Disciplines summary

MASTER'S DEGREE IN PROFILE "CONDENSED MATTER PHYSICS"

Course name Academic writing				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	18 weeks	compulsory	3	In-class-36, independent - 72

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	exam	Lectures Practical lessons A. N. Makhmutova	A. N. Makhmutova

Educational outcomes
As a result of the discipline acquisition a student: 1. must know: Tasks and objectives of written academic communication, peculiarities of scientific style of written and oral texts, organizational principals of scientific texts. 2. must be able to: - note down the main ideas and facts (from audio and written texts), as well as theses of oral/written reports on the studied issues; - carry out written project works (written design of presentations, research outcomes, etc.); - correctly organize their own ideas, clearly and satisfyingly express and back them up; 3. must have: - analysis skill of their own texts, - structuring technology of an academic text; - main methods of reading and creating of scientific and research texts, - methods of work with the competent bibliography, selecture of speech means suitable for scientific style of speech, - resume writing techniques and annotation of scientific articles, essays, research papers, grant proposals. 4. must show ability and willingness: - apply the skills of written communication in the academic and scientific-technical sphere in writing research papers.

Contents
Topic 1. Understanding academic convention in English writing *lecture (2 hours), practical lesson (2 hours):* Topic 2. The communication range of academic English *lecture (2 hours), practical lesson (2 hours):* Topic 3. Organizing the text in academic writing *lecture (2 hours), practical lesson (2 hours):* Topic 4. Writing an article: sections overview, content, order of creation. Writing an *lecture (2 hours), practical lesson (2 hours):* Topic 5. Writing about methodology. Writing Scientific Visuals & presentations *lecture (2 hours), practical lesson (2 hours):* Topic 6. Writing Results and Discussion/Conclusion Sections *lecture (2 hours), practical lesson (2 hours):* Topic 7. Writing the Abstract. *lecture (2 hours), practical lesson (2 hours):* Topic 8. Referencing and schools of citations *lecture (2 hours), practical lesson (2 hours):* Topic 9. Peculiarities of Scientific English: grammar, style, vocabulary, sentence structure and punctuation *lecture (2 hours), practical lesson (2 hours):*

Exemplary literature

Main literature:
1. A.N. Makhmutova ACADEMIC WRITING [Electronic resource]. Kazan: KFU, 2014.
//http://tulpar.kfu.ru/course/view.php?id=520
2. G.A. Bagautdinova, I.I. Lukina. English for postgraduates and job seekers: Study guide. / Authors G.A. Bagautdinova, I.I. Lukina.- Kazan: KFU, 2012 - 134p.
//http://kpfu.ru/main_page?p_sub=7108
3. A.Yu. Polenova. A.S. Chislova. A Complete Guide to Modern Writing Forms. Modern forms of writing in English. - M.: INFRA-M: Akademtsentr, 2012. – 160p.
//http://znanium.com/bookread.php?book=235606
4. I.I. Stamova. Writinf in English: introduction to the practical course: for first-year students of polytology department. / I.I. Stamova. - M.: MGIMO - University, 2011. - 83 p. (ELS "Bibliorossika" http://www.bibliorossica.com/book.html?currBookId=7264).
5. L.V. Kryvoshlykova, N.M. Nesova. Taking postgraduate exam: Study guide / L.V. Kryvoshlykova, N.M. Nesova. - M.: RFUR, 2012 - 73 p.
(http://www.bibliorossica.com/book.html?currBookId=10360).
Additional literature:
1. Hamp-Lyons L., Heasley B. Study writing: a course in writing skills for academic purposes. / L. Hamp-Lyons, B. Heasley. - Cambridge: Cambridge University Press, 2008. - 213 p. (SL

named after Lobachevsky).

2. Seely, John. The Oxford guide to writing and speaking / J.Seely . - Oxford ; N.Y. : Oxford Univ. Press, 2000 . - IX, 304 p. - Ind.: p. 297-302 . - ISBN 0-19-280109-0 : 65.00. (SL named after Lobachevsky).

3. McCarthy, Michael. Academic vocabulary in Use : 50 units of academic vocabulary reference and practice : self-study and classroom use / Michael McCarthy, Felicity O'Dell . [2nd ed.] . [Cambridge etc.] : Cambridge University Press, [2009] . - 176 p. : image. ; 26 . - Order.: p. 167-176 . - ISBN 978-0-521-68939-7 (paperback). (SL named after Lobachevsky).

Internet resources:

Academic writing - study advice (university of Reading) -

http://www.reading.ac.uk/internal/studyadvice/studyresources/sta-academic.aspx

Academic Writing Center (ВШЭ) - http://academics.hse.ru/writing_skills

Academic writing for undergraduate students (Monash university) -

http://www.reading.ac.uk/internal/studyadvice/studyresources/sta-academic.aspx

Advice on academic writing (University of Toronto) - - http://www.writing.utoronto.ca/advice

Purdue University - http://owl.english.purdue.edu/owl/resource/606/1/Purdue University

Course name Philosophic questions of natural scince				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
2	18 weeks	compulsory	2	In-class-18, independent - 54

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	exam	Lectures	A.L. Larionova

Educational outcomes

As a result of the discipline acquisition a student:

1. must know:

- the most important and enduring achievements of the world of philosophy, which play a key role in shaping the modern scientific worldview

2. must be able to:

- analyze the processes that have led to important discoveries in the natural sciences, due to the ideological atmosphere of the time

3. must have:

- information on the main directions of development of natural sciences

4. must demonstrate the ability and readiness for: further studies

Contents

Topic 1. Philosophy and natural science

lecture (2 hours):

Topic 2. Basic physical quantities as the quantity of natural objects.

lecture (2 hours):

Topic 3. Fundamental interactions.

lecture (2 hours):

Topic 4. Large-scale dynamics of the Universe.

lecture (2 hours):

Topic 5. The evolution of stellar systems.

lecture (3 hours):

Topic 6. Energy sources of stars.

lecture (2 hours):

Topic 7. The internal structure and the shell of the Earth..

lecture (2 hours):

Topic 8. The advent of life on Earth from the point of view of physics, chemistry and biology.

lecture (3 hours):

Exemplary literature

Main literature:

1. Yu.P. Petrov. History and philosophy of science: mathematics, informatics, computing technology: [Study guide] / Yu. P. Petrov – Saint-Petersburg: BKhV-Petersburg, 2012.- 441 p.

2. V.A. Kanke. Philosophy of maths, physics, chemistry, biology (Study guide) - M.: Knorur. - 2011. - 368 p.

3. N.R. Altshuler, A.L. Larionov, I.A. Larionov. Prominent representatives of domestic natural and exact sciences: Biographical and institutional reference. EOR. [Electronic resource] http://tulpar.kpfu.ru/course/view.php?id=102 .

4. A.L. Larionov. History and methodology of physics: Antiquity and the Middle Ages. - Kazan, 2013 - [Electronic resource] http://kpfu.ru/docs/F515457482/History_Method_Physics.pdf

Additional literature:

1. V.A. Fok. Quantum physics and the structure of matter. - Librokom - 2013.

2. G. Gershel. Philosophy of natural science = Preliminary discourse on the study of natural philosophy: on the general character, benefits and principles of the study of nature: translation from English / G. Gershel. – 2 edition - Moskva: URSS: [LIBROKOM, 2011].-355 p.

Internet resources:

teaching materials of the department of TP - http://www.kpfu.ru/main_page?p_sub=8205

The new e-library - http://www.newlibrary.ru

The educational project of A.N. Vargin - http://www.ph4s.ru/index.html

Website of the Department of Theoretical Physics - http://www.kpfu.ru/main_page?p_sub=5721

ELS KnigaFund - http://www.knigafund.ru

ESM "Outstanding representatives of Russian natural and exact sciences:

Biographical and institutional reference "- http://tulpar.kfu-elearning.ru/course/view.php?id=102

Course name *Quantum physics*				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	16 weeks	compulsory	3	In-class- 30, independent - 42

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	exam	Lectures, practical lessons	R.Kh. Gaynutdinov

Educational outcomes

As a result of the discipline acquisition a student:

1. must know:

the fundamental principles of modern quantum theory; the main provisions of canon and the Feynman approach to quantum theory; the paradox of Einstein, Podolsky and Rosen, and the quantum Zeno paradox.

2. must be able to:

apply physical ideas underlying the Einstein-Podolsky-Rosen and paradox of Zeno, for applications of physics and quantum information; use textbooks in the field of quantum physics needed to find other sources of information and work with them.

3. must have: mathods of modern quantum physics.

4. must demonstrate the ability and readiness: to participate in research related to the solution of problems of modern quantum physics

Contents

Topic 1. Modern status of quantum physics.

lecture (2 hours):

Topic 2. The phenomenon of quantum interference

practical lesson (2 hours):

Topic 3. Basic principles of the canonical formulation of quantum theory.

lecture (2 hours):

Topic 4. The probabilistic nature of quantum mechanics.

practical lesson (2 hours):

Topic 5. The observed. The operator formalism..

lecture (2 hours):

Topic 6. Dynamic postulate.

practical lesson (2 hours):

Topic 7. The basic principles of the Feynman formulation of quantum mechanics.

lecture (3 hours):

Topic 8. Integrals over trajectories.

practical lesson (4 hours):

Topic 9. Unsolved problems of quantum physics.

lecture (3 hours):

Topic 10. The problems of quantum mechanics, nuclear phenomena.

practical lesson (4 hours):

Topic 11. Basic principles of quantum physics and the generalized quantum dynamics.

lecture (2 hours):

Topic 12. The physics of quantum information.

practical lesson (2 hours):

Exemplary literature

Main literature:

B.I. Kochelaev. Quantum theory: lectures / B.I. Kochelaev; KFU, Phisics institute, department of theoretical pphisics. [2 edition, edited and improved]. - Kazan: [Kazan university], 2013. - 222 p.

D.V. Sivukhin. General course in phisics: Study guide for HEIS: in 5 volumes / D.V. Sivukhin. - Moskva: Fizmatlit, 2006. - 22 see V. 5: Atomic and nuclear phisics. 3 edition, stereotypical. - Moskva: FIZMATLIT, 2006 .- 784 p: image.

R. Feinmann. A dozan of lectons: six easier and six more difficult: translation from English / R. Feinmann; Translation: E. V. Falyova, V. A. Nosenko. - M.: BINOM. Laboratory od knowledge, 2014. - 317 p.: ил. http://e.lanbook.com/books/element.php?pl1_id=50540

Additional literature:

A.N. Parshakov, Introduction into quantum phisics. - M.: "Lan", 2010. – 352 p.; http://e.lanbook.com/books/element.php?pl1_id=297

E.V. Shkolskiy, Atomic phisics. Volume 2. Bases of quantum machanics and structure of electronic shell of an atom. - "Lan", 2010. - 448 p; http://e.lanbook.com/books/element.php?pl1_id=443

A.R. Davydov. Quantum mechanics: Study guide. - SPb: BKhV Petersburgr, 2011. - 704 p. http://znanium.com/bookread.php?book=351130

Internet resources:

R.Kh. Gaynutdinov, A.A. Kalachyov, A.A. Mutygullina, M.A. Khamadeev, M.Kh. Salakh. Atom-field interaction of laser radiation and resonance fluorescence. Kazan 2013, 32 p. - Http://shelly.kpfu.ru/e-ksu/docs/F1215185736/metodichka.VZAIMODEJSTVIE.ATOMOV.S.POLEM..pdf

R. Kh. Gaynutdinov. The paradoxes of quantum mechanics, quantum Zeno paradox / R.Kh. Gaynutdinov, A.A. Mutygullina. Study guide for first year undergraduates of physical department. Scientific editor – M. Kh. Salakh. - 2009 - Kazan, KFU. - 18 p. (1.5 pp) - http://shelly.kpfu.ru/e-ksu/docs/F1341557413/Zeno.paradox.pdf

Quantum field theory. Physical encyclopedia -

http://www.femto.com.ua/articles/part_1/1562.html

Quantum phisics -

http://ru.wikipedia.org/wiki/%D0%9A%D0%B2%D0%B0%D0%BD%D1%82%D0%BE%D0%B2%D0%B0%D1%Популярный ресурс по современной физике - http://ysfine.com/

Course name Collective excitations in solids				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	16 weeks	compulsory	2	In-class- 24, independent - 48

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	exam	Lectures, practical lessons	R.G. Deminov

Educational outcomes

As a result of the discipline acquisition a student:

1. must know:

ways to describe the quantum many-particle systems

2. must be able to:

apply the concept of elementary excitations to describe the main characteristics of the phenomenon of superfluidity, superconductivity and magnetism

3. must have:

the skills of the approximate solution of the problem of the energy spectrum of elementary excitations

4. must demonstrate the ability and readiness for:

further education

Contents
Topic 1. Second quantization Topic 2. The superfluidity of liquid helium Topic 3. Magnetism dielectrics Topic 4. Superconductivity of Metals

Exemplary literature
Main literature: 1. Yu.V. Petrov. Fundamentals of condensed matter physics: [Study guide] / Yu.V. Petrov.- Dolgoprudniy: Intellekt, 2013. - 213 p. 2. Yu. A. Baykov. Condensed matter phisics. M. Binom. Laboratory of knowledge. - 2011. - 293 p. http://e.lanbook.com/view/book/4372 3. M.V. Eremin. Microscopic models in condensed matter [Electronic resource] // Study guide. - Kazan: Kazan (Volga region) Federal University, 2011. - 113p. Access mode http://kpfu.ru/docs/F1043614157/Eremin_Posobie_2011.doc Additional literature: 1. M.G. Khusainov. Quantum physics of condensed state: Study guide / M.G. Khusainov, E.L. Parfyonov, L.A. Terentiev; Ministry of Education and Science of the Russian Federation. Federal budgetary educational institution of higher professional education "Kazan national research technical university named after A.N. Tupolev-KAI".? Kazan: [Publishing House of Kazan State Technical University], 2013.-117 p. 2. A.A. Abrikosov. Fundamentals of the theory of metals M. FIZMATLIT. - 2010. - 600 p. http://e.lanbook.com/view/book/2093/ Internet resources: teaching materials of the department of TP - http://www.kpfu.ru/main_page?p_sub=8205 The new e-library - http://www.newlibrary.ru The educational project of A.N. Vargin - http://www.ph4s.ru/index.html website of the Department of Theoretical Physics - http://www.kpfu.ru/main_page?p_sub=5721 ELS KnigaFund - http://www.knigafund.ru

Course name ***Physics of polymers***				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	12 weeks	compulsory	2	In-class- 24,

				independent - 48

Enrollment requirements	Exam type (oral, written, course work, etc.)	Educational methods (lectures, seminars, etc.)	Course coordinator
	exam	Lectures, practical lessons	R.V. Sushkov

Educational outcomes
As a result of the discipline acquisition a student: 1. must know: - basic concepts and facts of relativistic kinetics and thermodynamics, mathematical and physical foundations of cosmology. 2. must be able to: - understand the basic principles and approaches in cosmology. 3. must have: - the basic techniques of relativistic calculations of the kinetics and thermodynamics, mathematical basics of cosmology. 4. must demonstrate the ability and readiness: - to solve theoretical problems in cosmology

Contents
Topic 1. Basics of relativistic kinetics and thermodynamics. Introduction to astrophysics: stars, white dwarfs, neutron stars, black holes and wormholes. lecture (2 hours), practical lesson (2 hours): Topic 2. Mathematical foundations of cosmology. lecture (3 hours), practical lesson (3 hours): Topic 3. Physical foundations of cosmology. lecture (3 hours), practical lesson (3 hours): Topic 4. Large-scale structure of the universe. Theories of galaxy formation and their clusters. lecture (2 hours), practical lesson (2 hours): Topic 5. The key problems of modern cosmology. lecture (2 hours), practical lesson (2 hours):

Exemplary literature
Main literature: 1. V.N. Lukash, E.V. Mikheeva, Physical cosmology. - M.: FIZMATLIT, 2012. - 404 p. http://e.lanbook.com/view/book/5279/; http://rffi.molnet.ru/rffi/ru/books/o_26680 (RFBR website) 2. V.E. Fortov. Extreme states of matter. - M.: FIZMATLIT, 2009. - 304 p .; http://e.lanbook.com/books/element.php?pl1_id=2154. 3. V.P. Beskin. Gravity and Astrophysics. - M.: FIZMATLIT, 2009. - 158 p. http://e.lanbook.com/books/element.php?pl1_id=2114. Additional literature: 1. A.A. Grib. The basic ideas of modern cosmology. - M.: FIZMATLIT, 2008. - 108 p. http://e.lanbook.com/books/element.php?pl1_id=2168. 2. The theory of relativity, gravity and geometry = Relativity, gravity and geometry: International Conference "Petrov 2010 Anniversary Symposium on General Relativity and Gravitation", 1-6 November, 2010, Kazan Works / [Ed.: A. Aminov, P.V. Sushkov]. - Kazan: Kazan University, 2010. - 274 p.: image. Internet resources: Archive of electronic publishing of scientific articles - www.arxiv.org. Library EqWorld WORLD of MATHEMATICAL EQUATIONS - http://eqworld.ipmnet.ru/indexr.htm Site of the theory of relativity and gravitation of KFU - http://old.kpfu.ru/f6/k6/index.php Digital Library of Mathematical-Mechanics Department of Moscow State University - http://lib.mexmat.ru/allbooks.php Electron library system - http://www.knigafund.ru/

Course name Modern problems of condensed matter physics				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	12 weeks	compulsory	2	In-class- 24, independent - 48

Enrollment requirements	Exam type (oral, written, course work, etc.)	Educational methods (lectures, seminars, etc.)	Course coordinator
	exam	Lectures, practical lessons	M.N. Eremin

Educational outcomes
As a result of the discipline acquisition a student:

1. must know:

quantum-mechanical description of superconductivity, basic thermodynamic and kinetic characteristics, communication model spin and orbital angular momenta; current trends in research in condensed matter physics.

2. must be able to:

to apply modern methods of the theory to solve problems; be able to identify unsolved problems; use this knowledge in solving actual problems.

3. must have:

have the skills to work with the scientific literature, methods of research; development of new methods in physical research

4. must demonstrate the ability and readiness for:

further education

Contents

Topic 1. Basic characteristics of superconductors and prospects of their application

lecture (2 hours), practical lesson (2 hours):

Topic 2. Cooper pairs.

lecture (2 hours), practical lesson (2 hours):

Topic 3. High-temperature superconductors.

lecture (2 hours), practical lesson (2 hours):

Topic 4. The unusual pairing of mechanisms

lecture (2 hours), practical lesson (2 hours):

Topic 5. The new low-dimensional systems. Multiferroics.

lecture (4 hours), practical lesson (4 hours):

Exemplary literature

Main literature:

1. Yu.V. Petrov. Fundamentals of condensed matter physics: [Study guide] / Yu.V. Petrov .- Dolgoprudniy: Intellekt, 2013. - 213 p.

2. M.V. Eremin. Microscopic models in condensed matter [Electronic resource] // Study guide. - Kazan: Kazan (Volga region) Federal University, 2011. - 113p.

Access mode http://kpfu.ru/docs/F1043614157/Eremin_Posobie_2011.doc

3. Yu. A. Baykov. Condensed matter phisics. M. Binom. Laboratory of knowledge. - 2011. - 293 p. http://e.lanbook.com/view/book/4372

7.2. Additional literature:

1. M.V. Sadovsky. Diagrammatika. Edition 2, "IKI", Moscow - Izhevsk, 2010. - 282 p.

Access mode: http://sadovski.iep.uran.ru/RUSSIAN/LTF/DATA/Diagrammatica.pdf

2. A.A. Abrikosov. Fundamentals of the theory of metals M. FIZMATLIT. - 2010. - 600 p.

http://e.lanbook.com/view/book/2093/ ELS "Lan"

3. L.R. Tagirov, B.I. Kochelaev, R.G. Deminov, N.Kh. Useinov. Applications of two-time thermodynamic Green's functions in the solid state physics (Lectures in English). - Kazan: Kazan (Volga region) Federal University, 2012. - 101p.

http://kpfu.ru/docs/F237569143/Application_of_Green_functions.pdf

7.3. Internet resources:

Archives of pripints - http://arxiv.org/find/cond-mat

Newsletter PersT - http://www.nanometer.ru/2015/01/03/periodika_448606.html

MSU named after Lomonosov - shg.phys.msu.ru/educat/cond_mat/notes.html

The models of the pseudogap state in high-temperature superconductors. - http://sadovski.iep.uran.ru/RUSSIAN/LTF/reviews.htm

Models of the electronic structure of high-temperature superconductors - http://www.nano-journal.ru/images/6/62/Nano@0101Eremin.pdf

Course name *Physics of polymers*				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	12 weeks	compulsory	2	In-class- 24, independent - 48

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	exam	Lectures, practical lessons	N.F. Fatkullin

Educational outcomes
As a result of the discipline acquisition a student: 1. must know: - Theoretical foundations of physics of polymers 2. must be able to: - Apply the knowledge in the discipline "Physics of Polymers" in professional activities 3. must have: - Skills in solving computational problems related to the study of the properties of the polymer molecules and dilute solutions. 4. must demonstrate the ability and readiness: - To solve theoretical and practical problems in the field of "Physics of Polymers"

Contents
Topic 1. The ideal freely jointed chain. Kuhn segment. lecture (1 hours), practical lesson (1 hours): Topic 2. The distributional function of the Flory radius. The radius of gyration. Flory radius. Hydrodynamic radiup. lecture (1 hours), practical lesson (1 hours): Calculation of non-Gaussian corrections to the Green functions. lecture (1 hours), practical lesson (1 hours): Topic 4. Θ is the temperature. Θ -oblast. Z-factor of Flory swelling. The coefficient of swelling. lecture (1 hours), practical lesson (1 hours): Topic 5. mean-field approximation. lecture (1 hours), practical lesson (1 hours): Topic 6. The number of self-intersections a great chain in d-dimensional space. lecture (1 hours), practical lesson (1 hours): Topic 7. The equation for swelling ratio. lecture (1 hours), practical lesson (1 hours): Topic 8. macromolecule in an external compressive field. The partition. lecture (1 hours), practical lesson (1 hours): Topic 9. ψ-function. Free energy. Entropy. λ-operator. lecture (1 hours), practical lesson (1 hours): Topic 10. The ideal polymer chain in the pore. lecture (1 hours), practical lesson (1 hours): Topic 11. Capture the polymer chain potential well lecture (1 hours), practical lesson (1 hours): Topic 12. polymer globules formed by the self-consistent field. lecture (1 hours), practical lesson (1 hours):

Exemplary literature
Main literature: 1. Yu.D. Semchikov, P.F. Zhiltsov, R.D. Zaitsev. Introduction to polymer chemistry. - M: "Lan", 2014. - 224 p. http: //e.lanbook.com/books/element.php? Pl1_id = 4036 2. V.N. Kuleznev, V.A. Shershnev. Chemistry and physics of polymers. - M .: "Lan", 2014. – 368 p. http://e.lanbook.com/books/element.php?pl1_id=51931 3. Fundamentals of Innovation Materials: Monography / O.P. Sirotkin. - M .: INFRA-M, 2011. - 158 p. http://znanium.com/catalog.php?bookinfo=226469 Additional literature: 1. Materials science and technology of materials / A.M. Adaskina, V.M. Zuev. - M .: Forum 2010.

-336 p .: image http: //znanium.com/catalog.php? Bookinfo = 178874

2. V.G. Tsyrelson. Quantum chemistry. Molecules, molecular systems and solids: Study guide for HEIs. M .: BINOM. Knowledge Laboratory, 2012. - 525 p.

http://e.lanbook.com/view/book/3150/

Internet resources:

Institute of Macromolecular Compounds - http://imc.macro.ru:8080/web/guest/24;jsessionid=758a85e193ad7ba1bbc8175a5a6b

Department of Polymer Physics, Moscow State University - http://polly.phys.msu.ru/ru/history/history_polymer.html

Department of Chemistry and Physics of Polymers and Polymeric Materials. B.A. Dogadkin - http://hfp.mitht.ru/nauchrabot.htm

The laboratory of polymer materials and composites - http://nanospheres.ru/

St. Petersburg National Research Institute - http://books.ifmo.ru/file/pdf/693.pdf

Course name *Special physics workshop*				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
2	72 weeks	compulsory	3	In-class- 72, independent - 108

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	exam	Laboratory lessons	V.Yu. Petukhov

Educational outcomes

As a result of the discipline acquisition a student:

1. must know:

- Condensed matter physics. Physics of surfaces and thin films, methods of synthesis and study of nanostructures.

2. must be able to:

- Choose the hardware, prepare the equipment to work with experimental physics facilities;

3. must have:

- Analysis of received information using modern computer technology;

4. must demonstrate the ability and readiness:

- to carry out research of raised problems; formulate new problems arising in the course of scientific research; work with the scientific literature with the use of new information

technologies

Contents
Contents of the discipline Topic 1. Lab "Ferroelectrics. Properties and Application in Electronics" laboratory work (12 hours): Topic 2. Lab "Determining the size of the metal nanoparticles from plasmon resonance spectra" laboratory work (12 hours): Topic 3. Lab "Research of electroluminescence spectra of light-emitting diodes" laboratory work (12 hours): Topic 4. Lab "Study of thin films by ESR" laboratory work (12 hours): Topic 5. Lab "Study of the surface layers of solids by moving the X-ray beam." laboratory work (12 hours): Topic 6. Lab "Getting thin magnetic films on insulating substrates by RF magnetron sputtering." laboratory work (12 hours):

Exemplary literature
Main literature: 1. L. Novotny. Fundamentals of nanooptics: translation from English / L. Novotny, B. Hecht; Trans. from English. A.A. Konovko, O.A. Shutova; Ed. V.V. Samartseva. - M.: FIZMATLIT 2009. - 484 p.: image. 2. Yu.V. Petrov, Y. Fundamentals of condensed matter physics: [Study guide] / Yu.V. Petrov. - Dolgoprudny: Intellect, 2013. - 213 p. Additional literature: 1. V.V. Parfenov, R.Kh. Zakirov, A.T. Khasanov. Research of electroluminescence spectra of light-emitting diodes. -Kazan. -2013. -14p. http://kpfu.ru/docs/F654346696/led.pdf 2. V.V. Parfenov, N.V. Boltakova, L.R. Tagirov, A.L. Stepanov, R.I. Khaybullin. Determining the size of the metal nanoparticles plasmon from resonance spectra. - Kazan, 2012.- 21 p. http://kpfu.ru/docs/F2134677347/Razmery_Nanochastic_FTT.pdf Internet resources: magnetron sputtering thin films - http://www.russianelectronics.ru/leader-r/review/2195/doc/49951/ Optics of nanoparticles with plasmon resonance - http://scipeople.ru/course/3276/ X-ray analysis in the sliding beams - http://www.ibmc.msk.ru/content/Education/w-o_pass/MMoB/11.pdf Ferroelectrics and their properties - http://dic.academic.ru/dic.nsf/enc_physics/2722/%D0%A1%D0%95%D0%93%D0%9D%D0%95%D0%A2%Electronic paramagnetic resonance -

https://ru.wikipedia.org/wiki/%DD%EB%E5%EA%F2%F0%EE%ED%ED%FB%E9_%EF%

Course name Quantum theory of nonequilibrium processes				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	12 weeks	compulsory	3	In-class- 24, independent - 48

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	Exam	Practical lessons, laboratory works	R.R. Nigmatullin

Educational outcomes

As a result of the discipline acquisition a student:

1. must know:

the theoretical foundations of the method of nonequilibrium statistical operator of Zubarev and Mori-Zwanzig

2. must be able to:

use the knowledge of the theoretical foundations of quantum theory of nonequilibrium processes for the construction of kinetic equations describing non-equilibrium processes in quantum multisystems

3. must have:

skills of deriving kinetic equations for the model systems and solutions in the framework of nonequilibrium statistical operator

4. must demonstrate the ability and readiness for:

further education

Contents

Topic 1. Phenomenological thermodynamics of irreversible processes

practical lesson (2 hours), laboratory work (3 hours):

Topic 2. The method of nonequilibrium statistical operator

practical lesson (4 hours), laboratory work (3 hours):

Topic 3. Application of the nonequilibrium statistical operator

practical lesson (4 hours), laboratory work (3 hours):

Topic 4. The method of Mori-Zwanzig

practical lesson (2 hours), laboratory work (3 hours):

Exemplary literature
Main literature: 1. M.V. Eremin. Microscopic model in condensed matter / M.V. Eremin, Study guide. - Kazan:. KFU 2011, - 113p. http://kpfu.ru/docs/F1043614157/Eremin_Posobie_2011.doc 2. A.A. Khamzin, R.R. Nigmatullin. The method of nonequilibrium statistical operator and its application to the kinetic Ising magnet. - Kazan: Publishing House of Kazan University, 2011. - 87 p. http://kpfu.ru/portal/docs/F726314524/nonequilibrium_statistical_operator.pdf 3. P.V. Borisenok, A.P. Kondratiev. Quantum statistical mechanics. M .: FIZMATLIT 2011. - 136 p. http://e.lanbook.com/view/book/2672/ Additional literature: 1. I.A. Kvasnikov. Introduction to the theory of electrical conductivity and superconductivity / I.A. Kvasnikov.- Moscow: URSS: [LIBROKOM, 2010] .- 212 p .: image. 2. I.A. Kvasnikov. Quantum statistics / I.A. Kvasnikov. - M.: URSS: [KRASAND, 2011] 569 .-. Internet resources: Kh. M. Bikkin, I.I. Lyapilin. Non-equilibrium thermodynamics and physical kinetics. Ekaterinburg, Ural Branch of Russian Academy of Sciences, 2009. - 500 p. - Http://eqworld.ipmnet.ru/ru/library/books/BikkinLyapilin2009ru.pdf Teaching materials of the department of TP - http://www.kpfu.ru/main_page?p_sub=8205 World of mathematical equations EqWorld - http://eqworld.ipmnet.ru/ru/library/physics/statphys.htm The new e-library newlibrary.ru - http://www.newlibrary.ru/genre/nauka/fizika/termodinamika__statisticheskaja_fizika/ ELS KnigaFund. - Http://www.knigafund.ru ESM on www.twirpx.com. - Http://www.twirpx.com/files/#category_42

Course name Computer technology in science				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	14 weeks	compulsory	2	In-class- 26, independent - 46

Enrollment requirements	Exam type (oral, written, course work, etc.)	Educational methods (lectures, seminars, etc.)	Course coordinator
	exam	Lectures, practical lessons	Yu.N. Proshin

Educational outcomes
As a result of the discipline acquisition a student: 1. must know: basics of computer modeling and visualization solutions for physical problems 2. must be able to: use information technology to solve physical problems, find professional information in information networks 3. must have: basic skills of use of mathematical packages and LaTeX system for solving physical problems and presenting results 4. must demonstrate the ability and readiness for: further education

Contents
Topic 1. Computer science: information technology in physics. lecture (2 hours): Topic 2. Search of professional information on the Internet. lecture (2 hours), practical lesson (2 hours): Topic 3. Scientific graphics and animation, the basic techniques and methods. lecture (2 hours), practical lesson (2 hours): Topic 4. Preparation of professional publications and presentations (Word, MathType, Origin, Powerpoint) lecture (4 hours). practical lesson (4 hours): Topic 5. Basics of the publishing package LaTeX. Preparation of professional scientific publications and presentations. lecture (4 hours), practical lesson (4 hours):

Exemplary literature
Main literature: 1. Yu. N. Proshin. Computational Physics: Practical Course: study guide /

Yu. N. Proshin, I. M. Eremin .- Kazan State University, 2009 .- 179 p ..

2. L.F. Champaign. Solution of ordinary differential equations using MATLAB: Study guide / L.F. Champaign, I. Gladvel, P. Thompson; trans. from English. I.A. Makarov. - St. Petersburg [et al.]: Lan, 2009. - 299 p.

3. I.B. Petrov. Lectures on computing mathematics: Study guide / I.B. Petrov, A.I. Lobanov. - Moscow: the Internet University of Information Technology: Binom. Knowledge Laboratory, 2012 .- 522 p.

4. Yu.N. Proshin. Computational methods and mathenatical simulation: lectures. [Electronic resource] / Yu.N.Proshin, P.K. Saykin, R.G. Deminov - Kazan, Kazan Federal University, Institute of Physics, 2010. - 330 slides. http://mrsej.ksu.ru/pro/pdf_10/ChMMM_all_10.pdf

5. R.V. Porshnev. Computer simulation of physical processes in the package MATLAB. + CD [Electronic resource] / Publisher: "Lan", ISBN: 978-5-8114-1063-7, 2nd ed., Rev. 736 pp., 2011. Access Mode http://e.lanbook.com/books/element.php?pl1_cid=25&pl1_id=650

Additional literature:

1. J. Kepne. Parallel Programming in MATLAB environment for multicore and multi-node computers: [Study guide] / Jeremy Kepner; scientific. ed. D.V. Dubrov .- Moscow: Publishing House of the University of Moscow, 2013.- 292 p.

2. A.V. Krivilev. Fundamentals of computer mathematics with the use of MATLAB: Study guide / A.V. Krivilev .- Moscow: Lex-book, 2005. - 496 p.

3. R.P. Fedorenko. Introduction to Computational Physics: Study guide for HEIs / R.P. Fedorenko; Ed. A.I. Lobanov .- 2nd edition, revised and updated .- Dolgoprudny: Intellect, 2008 .- 504 p.

Internet resources:

Algorithms and methods - http://algolist.manual.ru/

The educational project of A.N. Vargin - http://www.ph4s.ru/index.html

Yu.N. Proshin. Computational methods and mat. modeling: Lectures. [Electronic

resource] / Yu.N. Proshin, P.K. Saykin, R.G. Deminov - Kazan, Kazan Federal University, Institute of Physics, 2010. - 330 slides. - Http://mrsej.kpfu.ru/pro/pdf_10/ChMMM_all_10.pdf

Website of the Department of Theoretical Physics of KFU - http://portal.kpfu.ru/main_page?p_sub=5721

Page of Professor Yu.N. Proshin - http://mrsej.kpfu.ru/pro

Electronic Library Exponent.ru - http://www.exponenta.ru/educat/

Course name Modern methods of synthesis and investigation of nanostructures				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	14 weeks	compulsory	2	In-class- 26, independent - 46

Enrollment requirements	Exam type (oral, written, course work, etc.)	Educational methods (lectures, seminars, etc.)	Course coordinator
	exam	Lectures, practical lessons	A.A. Bukharev

Educational outcomes
As a result of the discipline acquisition a student: 1. must know: Laws and physico-chemical processes of nano-objects model; Types and properties of nano-objects and nano-materials, characteristics of physical and chemical processes of synthesis; Have the theoretical knowledge about the physical causes of the so-called size effects, which are manifested in a variety of properties of nanostructures. Modern methods of investigation of nanostructures. Have knowledge about the practical use of nanotohnology. 2. must be able to: Select the desired experimental method to get this or that information about the properties of nanostructures. Use information tools and technologies, including original scientific monographs and articles for the interpretation of the results. On the basis of the results of simulation experiments develop a plan for nanomaterials, the criteria choices of nanotechnology; To be able to present the information and present the results of physical research 3. must have: Skills to use the acquired knowledge in the field of nanotechnology for solving professional problems 4. must demonstrate the ability and readiness for: systematic scientific analysis of professional issues of various levels of complexity; working with laboratory equipment and modern scientific equipment; conducting physical and chemical experiments.

Contents
Topic 1. Modern ideas about the features of the structure of the nanostructures, methods of their study. lecture (6 hours). practical lesson (7 hours): Topic 2. The technology of nanomaterials, their properties and applications. lecture (6 hours), practical lesson (7 hours):

Exemplary literature
Main literature: A.I. Gusev. Nanomaterials, nanostructures, nanotechnology / A.I. Gusev.? 2 editioin, corrected. - M .: FIZMATLIT, 2009. - 416 p.http: //e.lanbook.com/books/element.php? Pl1_id = 2173. A.A. Barybin, V.I. Tomilin, V.I. Shapovalov. Physical and technological bases of macro, micro and nanoelectronics. - M: FIZMATLIT, 2011. - 784p. http: //e.lanbook.com/view/book/5258. I.I. Stoykov. Basics of nanotechnology and nanochemistry: [Study guide] / I.I. Stoykov, G.A. Evtyugin; Kazan (Volga Region) Federal University, Chemical Institute named after A.M. Butlerov. - Kazan: [KFU], 2010. - 236 p .: ill. 7.2. Additional literature: A.A. Eliseev. Functional Nanomaterials: Study guide for senior students of the major 020101 (011000) - Chemistry / A.A. Eliseev, A.V. Lukashin; ed. By Acad. Yu.D. Tretyakov. - Moscow: FIZMATLIT 2010.? - 452 p. : image., color. image, portr, table. Scanning electron microscopy for nanotechnology methods and application / edited by U. Zhu, J.L. Whang; trans. from English. - M .: Binom. Knowledge Laboratory, 2013 - 582 p. http://e.lanbook.com/books/element.php?pl1_id=8689 7.3. Internet resources: NanoNewsNet - News Nanotechnology - http://subscribe.ru/catalog/science.news.nanonews Internet magazine on nanotechnology - http://www.nanojournal.ru/ Scientific-popular site on nanotechnology - http://kbogdanov5.narod.ru/ National Nanotechnology Network - http://www.rusnanonet.ru/ Site of nanotechnology community Nanometer - http://www.nanometer.ru

Course name ***Foreign language***				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
2	30 weeks	compulsory	2	In-class- 30, independent - 42

Enrollment requirements	Exam type (oral, written, course work, etc.)	Educational methods (lectures, seminars, etc.)	Course coordinator
	exam	Lectures, practical lessons	A.N. Makhmutova

Educational outcomes
As a result of the discipline acquisition a student: 1. must know: -rules for design of oral and written monologue and dialogue speech situations of business and professional communication; -rules for preparation and execution of scientific and technical documents, research reports, surveys, reports and articles. - translation rules of grammatical structures while reading business and scientific literature, own business and scientific terminology. - bases of public speech (making posts, reports and presentations with preparation). 2. must be able to: - understand the oral (monologue and dialogue) professional speech; - understand, translate, abstract and annotate literature on narrow and wide profile of specialty; - translate, abstract and annotate business and scientific literature; talk in English on the study discipline. - sort out primary and secondary information when reading the adapted and original literature; - design the information in the form of abstract, reports, annotations - independently raise the level of language competence, competently and efficiently using a variety of reference books, dictionaries, and Internet resources. 3. must have: - written and spoken language for reading business and scientific literature; - skills of understanding business and scientific speech in English. - basic written communication skills necessary to conduct correspondence in the professional and scientific purposes; - skills for oral communication and apply them to communicate on topics of educational, general scientific and professional communication with the norms and rules of the English language etiquette; - various kinds of reading adapted and original literature (the viewing, searching, analytical and in order to extract specific information); must demonstrate the ability and readiness to: - participate in the discussion of scientific discourse, expressing certain communicative intention; - present prepared monologic messages on the profile of their scientific specialty / threads arguments outlining their position and using aids (graphs, tables, diagrams, Power Point, etc.); - understand the scientific and professional spoken language; - have skills of reading original literature in the specialty of different functional styles and genres, and make annotations, abstracts, theses, conduct business correspondence; - read and understand with a dictionary specialized literature on a wide and a narrow profile of the specialty.

Contents
Topic 1. Careers in science

practical lesson (4 hours):

Topic 2. Scientific collaboration

practical lesson (4 hours):

Topic 3. Critical thinking, reading and writing techniques.

practical lesson (4 hours):

Topic 4. Describing and discussing an experiment.

practical lesson (4 hours):

Topic 5. Presenting data of your research

practical lesson (2 hours):

Topic 6. Developing writing skills in science

practical lesson (4 hours):

Topic 7. Presenting your research

practical lesson (6 hours):

Topic 8. Socialising at a conference

practical lesson (2 hours):

Exemplary literature

Main literature:

1. A.N. Makhmutova Master English for Physics and Engineering Sciences [Electronic resource]. Kazan: KFU, 2014. // http://tulpar.kfu.ru/course/view.php?id=106

2. G.A. Bagautdinova, I.I. Lukina. English for post-graduate students: Study guide. / Authors G.A. Bagautdinova, I.I. Lukina.- Kazan: KFU, 2012- 134p. //http://kpfu.ru/main_page?p_sub=7108

3. A. Yu. Polenova, A.P. Chislova. A Complete Guide to Modern Writing Forms. Modern formats of writing in the English language. - M.: INFRA-M: Akademtsentr, 2012. - 160p.

//http://znanium.com/bookread.php?book=235606

4. O.V. Sipols. Develop Your Reading Skills: Comprehention and Translation Practice. Teaching reading and translation (English) [Electronic resource]. - M.: Flint: Science, 2011. - 376

p. // http://znanium.com/bookread.php?book=409896

5. Z.V. Mankovskaya. Grammar for business communication in English (modular competence-based approach). - M .: SIC Infra-M, 2013. - 140 p. //

http://znanium.com/bookread.php?book=342084

6. Communicative English for physicists. A teaching guide for students of Physics Department http: //diglib/kpfu.ru/jspui/bitstream/123456789/503/1/CEng_phys.pdf

7. V.V. Popova, E.P. Kashirina. Effective Commenting On The Text. - M .: Publishing House: Prometheus, 2011. - 49p. - http://www.bibliorossica.com/book.html?currBookId=4356

Additional literature:

1. T.B. Ivanova, A.A. Kozlov, E.A. Zhuravleva. Methodology of Scientific Research (research methodology): Publisher: Peoples' Friendship University, Moscow, 2012 - 81p. //http://www.bibliorossica.com/book.html?currBookId=10310

2. L.V. Zenina. Get ready for the postgraduate entrance English exam (Working with Texts). - M.: Publishing House EAOI center, 2009. - 216p.

//http://www.bibliorossica.com/book.html?currBookId=6069

3. A.A. Perevalova. Information Technology: Study guide / A.A. Perevalova, N.I. Klykova; Ministry of Education and Science of the Russian Federation, the SEI HVE "Kemer. mount. Univ." - Kemerovo [Kemerovo State University], 2009.-131 p.

4. L.V. Kvasova. The English language in computer engineering and technology - Professional English for computing: Study guide in the direction "Information Technology" and "Computers" / L.V. Kvasova, R. L. Podvalniy, O.E. Safonova. - 2nd ed., - Moscow: KNORUS, 2012.-172 p.

5. I.F. Turuk. Grammar basics of reading a special text. M.:. Publishing Center EAOI 2009.

- 152p. //http://www.bibliorossica.com/book.html?currBookId=6100

6. I.P. Rushinskaya. The English Verbals and Modals: Workshop. – M: Flinta: Nauka, 2003. - 48 p.

(E-book) // http://znanium.com/catalog.php?bookinfo=320797

7. L.D. Krivykh. Technical Translation: Educational handbook. - M.: Forum, 2008. -

184p. //http://znanium.com/catalog.php?bookinfo=144081

8. E.N. Agapov. Workshop on professionally-oriented translation for physics students: Study guide: Orenburg State University, Orenburg, 2011. - 186p. //http://www.bibliorossica.com/book.html?currBookId=9048

Internet resources:

Advice on handling questions - http://www.presentationdynamics.net/tag/handling-questions/

Advice on how to make a poster - http://www.swarthmore.edu/NatSci/cpurrin1/posteradvice.htm

Articles in Physics - http://www.nobelprize.org/nobel_prizes/themes/physics/

Creating Effective Poster Presentations - http://www.ncsu.edu/project/posters/NewSite/index.html

Designing Effective Oral Presentations - http://riceowl.rice.edu/guidance.cfm?doc_id=11775

Examples of Posters - http://www.ncsu.edu/project/posters/NewSite/ExamplePosters.html

How to Get the Most Out of Scientific Conferences -

http://chronicle.com/article/How-to-Get-the-Most-Out-of-/46399

Physics - http://www.buzzle.com/articles/physics/

Course name *Nonaphisics*				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	10 weeks	Optional	3	In-class- 24, independent - 48

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	exam	Lectures,	L.R. Tagirov

		laboratory works	

Educational outcomes
As a result of the discipline acquisition a student: 1. must know: especially the physical phenomena on the nanoscopic scale and the physical basis of modern equipment for the production and investigation of nanostructures. 2. must be able to: use reference and textbooks in the field of physics of nanostructures and nanotechnology, find other relevant information sources and work with them. 3. must have: theoretical knowledge of the fundamental concepts of quantum theory and statistical physics of nanoscopic and mesoscopic systems. 4. must demonstrate the ability and readiness: for further study.

Contents
Topic 1. Introduction. lecture (1 hours): Topic 2. Fundamentals of the theory of quantum phenomena. lecture (2 hours): Topic 3. Preparation of nanostructures. lecture (2 hours), laboratory work (2 hours): Topic 4. Preparation of nanostructures. lecture (1 hours), laboratory work (2 hours): Topic 5. Methods of research of nanostructures. lecture (1 hours), laboratory work (2 hours): Topic 6. Transport phenomena in nanostructures. lecture (1 hours): Topic 7. Superconductivity in mesoscopic sisTopich. lecture (1 hours): Topic 8. Magnetic properties of nanostructures. lecture (1 hours), laboratory work (2 hours): Topic 9. Allotropes of carbon. lecture (1 hours), laboratory work (1 hours): Topic 10. Photonic crystals lecture (1 hours), laboratory work (3 hours):

Exemplary literature
Main literature: 1. R.A. Andrievsky. Fundamentals of nanostructured materials . Opportunities and challenges. - M: "Binom. Knowledge Laboratory," 2012 .- 186p. http://e.lanbook.com/books/element.php?pl1_id=3133 2. Methods for the preparation and study of nanomaterials and nanostructures. Laboratory workshop on Nanotechnology: Study guide / ed. By A. R. Sigova. - M. "Binom. Knowledge Laboratory", 2013. - 184p. http://e.lanbook.com/books/element.php?pl1_id=42636. 3. Scanning electron microscopy for nanotechnology: methods and applications: trans. from English. / ed. by U. Zhu, J.L. Whang. - M.: "Binom. Laboratory of Knowledge", 2013. - 582 p. http://e.lanbook.com/books/element.php?pl1_id=8689 7.2. Additional literature: 1. A.I. Gusev. Nanomaterials, nanostructures, nanotechnology / A.I. Gusev. 2nd edition, corrected. - M.: FIZMATLIT, 2009. - 416 p. http://e.lanbook.com/books/element.php?pl1_id=2173. 2. Quantum challenge: current research foundations of quantum mechanics: [Study guide] / J. Greenstein, A.G. Zayonts; translation of 2nd edition under ed. and with add. of V.V. Aristov, A.V. Nikulov; ext. to the 2nd ed. in Russian A.V. Nikulov. - 2nd ed., [Extra].. - Dolgoprudny: Intelligence, 2012. - 431 p.: image. 7.3. Internet resources: Journal of Nanotechnology - http://www.nanoru.ru/ Nanometer - http://www.nanometer.ru/ Nanotechnology Now - http://www.nanotech-now.com/ News of nanotechnology - http://www.sciencedaily.com/news/matter_energy/nanotechnology/ Rosnano - http://www.rusnano.com/

Course name Nanomaterials and methods of research				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	10 weeks	Optional	3	In-class- 24, independent - 48

Enrollment requirements	Exam type (oral, written, course work, etc.)	Educational methods (lectures, seminars, etc.)	Course coordinator
	exam	Lectures, laboratory works	L.R. Tagirov

Educational outcomes
As a result of the discipline acquisition a student: 1. must know: - elements of condensed matter physics, the dependence of physical properties of materials on the topology of the Fermi surface, the role of the volume and the surface of the physical properties of nanoscale objects; 2. must be able to: - assess the impact of quantum size effects on phase transformations, and phase diagrams of nanoparticles in thin films and bulk nanomaterials, take into account the conditions for the emergence of new stationary states in dissipative structures, study the properties (mechanical, electrical, optical, etc.). Nanomaterials and nanosystems; 3. must have: - skills of scientific analysis of the problems of the system (both natural and professional) of various levels of complexity; methods of computational physics in relation to nanomaterials, methods of quantum mechanics, theoretical research 4. must demonstrate the ability and readiness: - for further study.

Contents
Topic 1. Introduction to the physics of nanomaterials. lecture (1 hours): Topic 2. Classification of disperse systems. lecture (1 hours): Topic 3. Methods for producing nanoscale materials. lecture (2 hours). laboratory work (4 hours): Topic 4. Physical and chemical bases of reception of nanostructured materials. lecture (2 hours), laboratory work (2 hours): Topic 5. The size dependence of the properties of nanomaterials. lecture (2 hours), laboratory work (2 hours): Topic 6. Methods of studying the properties of nanomaterials. lecture (2 hours), laboratory work (4 hours): Topic 7. The use of nanomaterials in practice. lecture (2 hours):

Exemplary literature
Main literature: Yu.N. Petrov. Fundamentals of condensed matter physics: [Study guide] / Yu.N. Petrov.- Dolgoprudny: Intellect, 2013. - 213 p. 2. A.A. Barybin, V.I. Tomilin, V.I. Shapovalov. Physical and technological bases of macro, micro

and nanoelectronics. - M .: FIZMATLIT, 2011. - 784p.

3. Scanning electron microscopy for nanotechnology: methods and applications: trans. from English. / ed. by U. Zhu, J.L. Whang. - M .: "Binom. Laboratory of Knowledge", 2013. - 582 p. http://e.lanbook.com/books/element.php?pl1_id=8689

7.2. Additional literature:

1. A.I. Gusev. Nanomaterials, nanostructures, nanotechnology / A.I. Gusev. 2nd ed. corrected. - M.: FIZMATLIT, 2009. - 416 p. http://e.lanbook.com/books/element.php?pl1_id=2173.

2. Quantum challenge: current research foundations of quantum mechanics: [Study guide] / J. Greenstein, A.G. Zayonts; trans. of 2nd ed. under ed. and add. by V.V. Aristov, A.V. Nikulov; ext. to the 2nd ed. in Russian A.V. Nikulov. - 2nd ed., [Extra]. - Dolgoprudny: Intelligence, 2012. - 431 p.: image.

7.3. Internet resources:

www.nanometer.ru - www.nanometer.ru

http://perst.isssph.kiae.ru/Inform/index_tem.htm

www.portalnano.ru - www.portalnano.ru

Site of nanotechnology in Russia - http://www.nanonewsnet.ru/

Course name Methods of quantum field theory in statistical physics				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	16 weeks	Optional	4	In-class- 46, independent - 62

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	exam	Lectures, practical lessons	R.G. Deminov

Educational outcomes

1. must know:

diagram technique of the method of Green's functions

2. must be able to:

to apply this method to condensed matter physics

3. must have:

computation skills (within the diagram technique) of different properties of condensed systems

4. must demonstrate the ability and readiness for:

further education

Contents
Contents of te discipline Topic 1. Basic provisions. lecture (4 hours): Topic 2. Green's functions at zero temperature. lecture (14 hours), practical lesson (8 hours): Topic 3. Green functions at finite temperature. lecture (4 hours), practical lesson (4 hours): Topic 4. The theory of linear response. lecture (2 hours), practical lesson (2 hours): Topic 5. Non-equilibrium Green's function. lecture (3 hours), practical lesson (4 hours): Topic 6. Methods of quantum field theory of superconductivity. lecture (1 hours):

Exemplary literature
Main literature: Fundamentals of condensed matter physics, Yu.N. Petrov, 2013. 2. L.R. Tagirov, B.I. Kochelaev, R.G. Demin. N.Kh. Useinov. Applications of double-time thermodynamic Green's functions to solid state physics. Lectures.- Kazan: Kazan (Volga region) Federal University, 2012. 101 p. http://kpfu.ru/docs/F237569143/Application_of_Green_functions.pdf 3. P.V. Borisyonok, A.P. Kondratiev. Quantum statistical mechanics. M.: FIZMATLIT, 2011. - 136 p. http://e.lanbook.com/view/book/2672/Additional literature: Quantum physics and structure of matter, V.A. Fok, 2013. 2. V.A. Kashurnikov. A.N. Krasavin. Numerical methods of quantum statistics. M. FIZMATLIT. 2010. - 628 p. http://e.lanbook.com/view/book/2197/ Internet resources: Single window access to educational resources. Library - http://window.edu.ru/library Department of Quantum Statistics and Field Theory, Moscow State University. Library - http://statphys.nm.ru/biblioteka.html Laboratory of Theoretical Physics, Institute of Electrophysics - http://sadovski.iep.uran.ru/RUSSIAN/LTF/index.htm E.M. Lifshitz, L.P. Pitaevskiy. Statistical physics. Part 2. M.: FIZMATLIT, 2004. - http://www.knigafund.ru/books/87567 E.M. Lifshitz, L.P. Pitaevskiy. Physical Kinetics. M.: FIZMATLIT 2007 - http://www.knigafund.ru/books/87568

Course name Nonlinear dynamic structures				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	14 weeks	Optional		In-class- 46, independent - 62

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	exam	Lectures, practical lessons	Yu.V. Lysogorskiy

Educational outcomes

As a result of the discipline acquisition a student:

1. must know:

the basic provisions of the qualitative theory of differential equations, the terms and approaches of nonlinear dynamics and the theory of dynamical systems, used for the analysis of behavior of dynamic systems; including such concepts as bifurcation oscillations, synchronization, dynamic chaos

2. must be able to:

formulate the problem of analytical and numerical study of dynamical systems on the phase plane and three-dimensional phase space and select the appropriate theoretical and numerical methods for their solution

3. must have:

analytical methods of localization and analysis on the stability of equilibrium models of complex systems, computer methods of analysis of the stability of periodic solutions, specialized evaluation methods to measure chaotic motion on the attractor in the phase space of the model system.

4. must demonstrate the ability and readiness:

to work independently

Contents

Topic 1. Introduction

lecture (2 hours), practical lesson (2 hours):

Topic 2. Basic concepts of the theory of dynamical systems

lecture (2 hours), practical lesson (2 hours):

Topic 3. Equilibrium states and their stability

lecture (4 hours), practical lesson (2 hours):

Topic 4. Elements of bifurcation theory

lecture (4 hours), practical lesson (2 hours):

Topic 5. Bifurcation mechanisms of self-oscillations of birth

lecture (4 hours), practical lesson (2 hours):

Topic 6. Synchronization of self-oscillations and bifurcations on the torus

lecture (4 hours), practical lesson (2 hours):

Topic 7. Deterministic chaos

lecture (4 hours), practical lesson (2 hours):

Topic 8. Fractals

lecture (4 hours), practical lesson (4 hours):

Exemplary literature

Main literature:

1) V.G. Usychenko, R.A. Gridnev, Yu.E. Kalinin, A.V. Sitnikov, O.V. Stogney. Nonlinear phenomena in nano- and microheterogeneous systems. - M. "Binom. Laboratory of Knowledge", 2012. - 448 p.

http://e.lanbook.com/books/element.php?pl1_id=3137

2) V.G. Usychenko. E-synergy. Physical basis of self-organization and evolution of matter: Lectures /. - M.: "Lan", 2010. - 240 p.

http://e.lanbook.com/books/element.php?pl1_id=553

3) A.V. Kolesnichenko, M.Ya. Marov. Turbulence and self-organization. - M.: Binom. Knowledge Laboratory, 2012. - 632 p. http://e.lanbook.com/view/book/4382/

Additional literature:

1) E.B. Pelyukhova, E.E. Fradkin. Synergetics in physical processes: the self-organization of physical systems. - M: "Lan", 2011. - 448 p. http://e.lanbook.com/books/element.php?pl1_id=649

2) V.A. Ilyin. System MAXIMA of analytical calculations for theoretical physicists / V.A. Ilyin, P.K Silaev - Moscow; Izhevsk: [Regular and chaotic dynamics], 2009.? 138 p.

Internet resources:

Fractal structures in nonlinear dynamics -

http://journals.aps.org/rmp/abstract/10.1103/RevModPhys.81.333

Wikipedia -

http://ru.wikipedia.org/wiki/%D0%A2%D0%B5%D0%BE%D1%80%D0%B8%D1%8F_%D1%85%D0%B0%H nonlinear physics, chaos , catastrophe theory - http://www.ph4s.ru/book_ph_haos.html

The physics of chaos - http://chaos.phys.msu.ru/loskutov/PDF/Annot_the_physics_of_chaos.pdf

Fractals and chaos in dynamic systems - http://www.mmf.unn.ru/files/2014/01/Fractals-Chaos.pdf

Course name Nuclear physics research methods of condensed matter				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	7 weeks	Optional	2	In-class- 28 independent - 44

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	Exam	Lectures, practical lessons	F.G. Vagizov

Educational outcomes

As a result of the discipline acquisition a student:

1. must know:

- modern ideas about current problems and prospects of the nuclear-physical methods based on the use of achievements of modern physics and technology;

- the basic concepts of physical principles and types of nuclear-physical methods, especially their application and current trends in the development of these methods:

- innovative research results obtained with the use of nuclear methods and bases of interpretation.

2. must be able to:

- Use educational, scientific, popular scientific literature, the Internet for professional activities;

- Obtain quantitative estimates of the parameters and characteristic of objects of study of the experimental data obtained by nuclear-physical methods;

- Make calculations based on the results of the experiment carried out an elementary statistical analysis of experimental data.

3. must have:

- Skills to use modern techniques and methods of mathematical analysis of

experimental data to generate new knowledge on the physical properties of materials and phenomena studied by nuclear-physical methods of research;

4. must demonstrate the ability and readiness to:

- Identify the specific physical contents in applications for future activities with the use of nuclear-physical methods of research;

- Use the laws of nuclear physics in solving professional problems;

- Scientifically analyze the problems of the system (both natural and professional) of various

level of complexity;

- Working with laboratory equipment and modern scientific equipment during physical experiment;

- Analyze and systematize research results, process and provide input in the form of scientific reports, publications and presentations.

Contents
Topic 1. Section 1 of the Mossbauer Effect. lecture (2 hours), practical lesson (2 hours): Topic 2. The hyperfine structure of Mossbauer spectra. lecture (2 hours), practical lesson (2 hours): Topic 3. Combined methods of gamma-resonance lecture (2 hours), practical lesson (2 hours): Topic 4. The use of synchrotron radiation in Mossbauer experiments lecture (2 hours), practical lesson (2 hours): Topic 5. Section 2. The diffraction methods of investigation of crystals lecture (2 hours), practical lesson (2 hours): Topic 6. The main provisions of the kinematic theory of X-ray scattering. lecture (2 hours), practical lesson (2 hours): Topic 7. Factors influencing the intensity of secondary radiation lecture (2 hours), practical lesson (2 hours):

Exemplary literature
Main literature: 1. I.M. Kapitonov. Introduction to Nuclear and Particle Physics: a textbook for university students [Text] / I.M. Kapitonov - 4th Edition. - Moscow: FIZMATLIT 2010. - 512 2. D.V. Sivukhin. General course of physics: Study guide for higher education: in 5 volumes [Text] / D.V. Sivukhin, V. 5: Atomic and nuclear physics. - Edition 3, stereotypical. - Moscow: FIZMATLIT, 2006. - 784 p. 3. I.V. Savelyev. Course of general physics: Study guide for technical colleges: 5 volumes. [Text] / I.V. Savelyev. V. 5: Quantum optics. Atomic physics. Solid State Physics. Physics of an atomic nucleus and elementary particles. - Moscow: AST: Astrel, 2005. – 368p. Additional literature: 1. V.K. Ignatovich. Neutron optics [Text] / V.K. Ignatovich. - Moscow: FIZMATLIT, 2006. - 336 p. 2. G.V. Fetisov. Synchrotron radiation. Methods of studying the structure of materials: study guide for students of specialty 020101 (011000) - Chemistry [Text] / G.V. Fetisov, ed. by L.A. Aslanov. - Moscow: FIZMATLIT, 2007. - 671 [1] p. Internet resources: Great Soviet Encyclopedia [Electronic resource] - http://bse.sci-lib.com/ Scientific information portal of the All-Russian Institute of Scientific and Technical Information of Russian Academy of Sciences. Internet encyclopedia on the application of nuclear physics in medicine [Electronic resource]. - Http://science.viniti.ru Website Wikipedia free encyclopedia - http://ru.wikipedia.org

Site "Radiation – everything about radiation and safety measures!" -
http://rad-stop.ru/coremed.html/page/11/#.VHyIrsnb5qM
Site of radioactive isotopes in physical and chemical biology - http://molbiol.ru/bio/001/004.html

Course name *Scattering of X-rays, electrons, and neutrons to study the structure of condensed matter*				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
2	7 weeks	Optional	2	In-class- 28, independent - 44

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	Exam	Lectures, practical lessons	A.R. Khramov

Educational outcomes

As a result of the discipline acquisition a student:

1. must know:

- Methods and techniques for solving specific problems from the field of X-ray diffraction on crystalline systems;

- Methods and techniques for solving specific problems of the area of electron diffraction on crystalline systems;

- Methods and techniques for solving specific problems from the field of neutron diffraction on crystalline systems;

2. must be able to:

- Apply the laws of symmetry to determine the possible structure of the compound;

- Use the laws of crystallography, symmetry, diffraction for solving problems related to the properties of a solid body

3. must have:

- Methods of system analysis of problems (both natural and professional) of various levels of complexity;

- Methods of working with modern laboratory equipment;

- Methods of decoding the diffraction patterns of polycrystalline

4. must demonstrate the ability and readiness for:

- Scientific analysis of the problems of the system (both natural and professional) of various

levels of complexity;
- Working with laboratory equipment and modern scientific equipment;
- Carrying out a physical experiment

Contents
Topic 1. The phenomenon of diffraction lecture (2 hours): Topic 2. Laue interference function lecture (2 hours): Topic 3. Structural amplitude lecture (3 hours): practical lesson (4 hours): Topic 4. Factors affecting the intensity of the scattered radiation lecture (3 hours), practical lesson (4 hours): Topic 5. Basics of electron lecture (2 hours), practical lesson (3 hours): Topic 6. Fundamentals of neutron diffraction lecture (2 hours), practical lesson (3 hours):

Exemplary literature
Main literature: 1. M. Hamermesh. Group theory and its application to physical problems: translation from English. / M. Hamermesh; Yu.A. Danilov, - 3rd edition –M oscow: LIBROKOM, 2010. - 584 p.: image. 2. M.I. Kargapolov, Yu.I. Merzlyakov. Fundamentals of the theory of groups. - M.: "Lan". - 2009. - 288 p. http://e.lanbook.com/view/book/177 / 3. Yu.V. Petrov. Fundamentals of condensed matter physics: [Study guide] / Yu.V. Petrov. - Dolgoprudny: Intellect, 2013. - 213 p. 4. Materials science and technology of materials / A.M. Adaskina, V.M. Zuev. - M.: Forum, 2010. -336 p.: image. http://znanium.com/catalog.php?bookinfo=178874 5. Scanning electron microscopy for nanotechnology methods and application, ed. by U. Zhu, J.L. Whang; trans. from English. - M : Binom. Knowledge Laboratory, 2013. - 582 p. http://e.lanbook.com/books/element.php?pl1_id=8689 Additional literature: 1. E.R. Lyapin, A.Ya. Aizenshtat, M.M. Lesokhin. Exercises in group theory: Study guide. 2nd ed., - SPb: Publisher "Lan", 2010. - 272 p. http://e.lanbook.com/view/book/528/ 2. Reference microscopy for nanotechnology: translation from English / Mos. mount. Univ. named after M.Yu. Lomonosov, Moscow State University, scientific-educational Center for Nanotechnology; ed. by Nan Yao, Zhong Lin Wang; scientific editor of Russian edition I.V.

Yaminsky. - Moscow: Scientific World, 2011. - 711p., color. image.

3. Yu.A. Baikov. Condensed Matter Physics. - M.: Binom. Knowledge Laboratory, 2011. - 293 p. http://e.lanbook.com/view/book/4372

Internet resources:

Site of Institute of crystal - http: //www.mincrust.ru

Site of K(P)FU - http://kpfu.ru/docs/F565967864/RSA.P3.pdf

Site of K(P)FU - http://kpfu.ru/physics/struktura/kafedry/kafedra-fiziki-tverdogo-tela/metodi

Site of K(P)FU - http://kpfu.ru/docs/F1031488164/14_rsa5_2.pdf

Site of K(P)FU - http://kpfu.ru/docs/F565967864/RSA.P2.pdf

Site of K(P)FU - http://kpfu.ru/docs/F1718491023/12_rsa1_2_2.pdf

Course name *Theoretical Foundations of Spectroscopy*				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	18 weeks	Optional	4	In-class- 54, independent - 126

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	Exam	Lectures, practical lessons	L.R.Tagirov

Educational outcomes

As a result of the discipline acquisition a student:

1. must know:

- Modern theoretical level description of the spectra and the corresponding energy levels;

- Modern methods of experimental studies;

- The main methods of calculation;

2. must be able to: apply modern methods of theoretical analysis of the optical and microwave spectra;

3. must have:

the skills of scientific analysis of the problems of the system (both natural and professional) of various levels of complexity;

- Skills to analyze the data obtained by different experimental methods of spectroscopy of condensed state;

4. must demonstrate the ability and readiness to:

- understand the basic mechanisms and models describing the interaction shaping the energy level scheme, master the basic techniques of calculation of output of effective spin-spin Hamiltonians and operators of quasi-particle interaction;

- have theoretical knowledge about the existing model ideas in the theory of condensed matter and know how to use them;

- be oriented in existing approximations and acquire skills in practical calculations.

Contents
Topic 1. The theory of free atoms. lecture (2 hours): Topic 2. Introduction of angular momentum. lecture (2 hours): Topic 3. Therms of electron configurations of free atoms and ions lecture (4 hours): Topic 5. The fine structure of terms. lecture (2 hours): Topic 6. The calculation of energy terms lecture (2 hours): Topic 7. Comparison of energy scheme with experimental data lecture (2 hours): Topic 8. The splitting in the crystal field. lecture (2 hours): Topic 9. Hyperfine interactions. lecture (2 hours): Topic 10. X-ray spectra lecture (2 hours): Topic 11. The optical spectra of ions with unfilled 3d- and 4f- shells lecture (4 hours), practical lesson (4 hours): Topic 12. The probabilities of optical transitions lecture (2 hours): Topic 13. Electron paramagnetic resonance. lecture (4 hours), practical lesson (4 hours): Topic 14. Vibronic interaction. lecture (4 hours), practical lesson (4 hours): Topic 15. Photoelectron spectroscopy. lecture (2 hours (s), practical lesson (6 hours):

Exemplary literature
Main literature: 1. L.D. Landa.Theoretical Physics, Vol. 3 Quantum mechanics. Non-relativistic theory / L.D. Landau, E.M. Lifshitz. M. Science, 2009 2. N.A. Sergeev. Principles of Quantum theory of nuclear magnetic resonance: monograph / N. A. Sergeev, D. P. Ryabushkin. - Moscow: Logos, 2013. - 272 p. - ISBN 978-5-98704-754- http://znanium.com/catalog.php?bookinfo=469025 3. M.M. Zaripov. Fundamentals of the theory of electron paramagnetic resonance in crystals: a course of lectures / M.M. Zaripov. - Kazan State University, 2009. - 212 p.: image. Additional literature: 1. Electron paramagnetic resonance of ion in transition groups, Volume 2 / A. Abraham, B. Blini, Vol. 2, Mir, Moscow, 1973, 349p. 2. A.I. Smirnov, D.T. Sviridov. Theory of optical spectra of ions with incomplete electron shells, M.: Science, 1982. 3. Theory of optical spectra of the classical methods, part 1 / A.M. Leushin- Kazan, Kazan University. - 2007. - 107 p. http://kpfu.ru/publication?p_id=12478 Internet resources: Video lecture on crystal field theory - http://theopenacademy.com/content/lecture-28-transition-metals-2-crystal-field-theory Data on the energy levels of free ions - http://physics.nist.gov/cgi-bin/ASD/energy1.pl Lectures - http://mission.igic.bas.bg/downloads/Lecture2.pdf Toolkit - http://kpfu.ru/publication?p_id=12475 The calculation program of 3-j and 6-j symbols - http://www-stone.ch.cam.ac.uk/wigner.shtml

Course name ***Radiospectroscopy of condensed matters***				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	16 weeks	Optional	4	In-class- 54, independent - 126

Enrollment requirements	Exam type (oral, written, course work, etc.)	Educational methods (lectures, seminars, etc.)	Course coordinator
	exam	Lectures, practical lessons	G.V. Mamin

Educational outcomes
As a result of the discipline acquisition a student: 1. must know: Theoretical fundamentals of the phenomenon of magnetic resonance, including its interpretation of the classical and quantum effects causing the shape of the magnetic resonance relaxation mechanisms; 2. must be able to: understand and critically analyze the state of general physical information needed for formulating and solving problems; use the theoretical basics, the basic concepts and laws in the field of magnetic resonance spectroscopy; be aware of the advantages and disadvantages of specific implementations of magnetic resonance spectroscopy; 3. must have: building skills and attitudes of the experiments in the field of magnetic resonance and double resonance to address specific scientific and technological problems; 4. must demonstrate the ability and readiness to: Apply knowledge and skills in the field of magnetic resonance in the solution of fundamental and practical problems in the fields of physics, chemistry and biology.

Contents
Topic 1. Introduction to magnetic resonance. The classical theory. lecture (3 hours): Topic 2. Introduction to the magnetic resonance. Quantum theory. lecture (3 hours): Topic 3. Stationary techniques in magnetic resonance lecture (3 hours): Topic 4. Pulse techniques in magnetic resonance lecture (3 hours): Topic 5. Introduction to the theory of the crystal field lecture (3 hours): Topic 6. The use of the spin Hamiltonian for outputting the energy levels of the ion Mn2 + lecture (3 hours): Topic 7. The electronic and nuclear spin-lattice relaxation lecture (3 hours), practical lesson (3 hours): Topic 8. Interaction of nuclei and electrons in the atom. lecture (3 hours), practical lesson (3 hours): Topic 9. Magnetic resonance methods for substances in different aggregate states. lecture (3 hours), practical lesson (3 hours): Topic 10. Magnetic resonance techniques in medicine. NMR imaging. lecture (3 hours), practical lesson (3 hours): The two-dimensional Fourier transformation of the echo.

Topic 11. The observation of the ESR for radiation exposure substances.

lecture (3 hours), practical lesson (3 hours):

Topic 12. Determination of the number of paramagnetic centers. Types of standards.

lecture (3 hours), practical lesson (3 hours):

Exemplary literature

Main literature:

Course of General Physics, Vol. 5. Quantum Optics. Atomic physics. Solid State Physics. Physics of an atomic nucleus and elementary particles, 2007.

Magnetic resonance in chemistry and medicine, Freeman, Ray; V.A. Volinkin, 2009.

Fundamentals of the theory of electron paramagnetic resonance in crystals, M.M. Zaripov, 2009.

4. Electronic devices and equipment: Textbook / F.A. Tkachenko. - M.: INFRA-M; Mn.: New Knowledge, 2011. - 682 p.: image.; 60x90 1/16. - (Higher Education). (Hardcover) ISBN 978-5-16-004658-7. http://znanium.com/catalog.php?bookinfo=209952

5. Toolkit "Setting the spectrometer X-band Bruker Elexsys series and measuring the ESR spectra in a stationary mode" / Yu.R. Kutin, G.V. Mamin, R.B. Orlinskiy, N.I. Silkin // 2014 electronic educational resurp.

http://gmamin.kpfu.ru/MRpract/X_band_CW.pdf

6. Toolkit "Using the software module EasySpin in the analysis of magnetic resonance spectra" / G.V. Mamin, R.B. Orlinskiy, N.I. Silkin, I.N. Subacheva, R.V. Yusupov // 2014 electronic educational resorce.

http://gmamin.kpfu.ru/MRpract/easyspin.pdf

Additional literature:

1. R.A. Altshuler, B.M. Kozyrev. EPR of transition groups. Nauka, Moscow - 1972.

2. A. Abraham, B. Blini. Electron paramagnetic resonance of transition ions. V.1 and V.2. Ed. "The World", Moscow - 1973

3. A. Abraham. Nuclear Magnetism. Publisher Foreign Lit., 1963

4. I.V. Alexandrov. The theory of nuclear magnetic resonance. "Science" 1964

5. A.V. Kessenikh. Nuclear magnetic resonance. "Knowledge", 1965

6. M.M. Zaripov. Fundamentals of the theory of electron paramagnetic resonance in crystals. Publisher Kazan State University, 2009. - 208 p.

7. A. Loesche. Nuclear induction. Publisher Foreign Lit. 1963

8. E. Andrew. Nuclear Magnetic resonance. Publisher Foreign Lit. - 1957

9. J. Pople., V. Schneider, T. Bernstein. High-resolution NMR spectra. Publisher Foreign Lit. - 1962.

10. Vertts. J. Bolton. George. The theory and practical application of the EPR method. "The World", Moscow - 1975.

11. Peter A. Rinck. Magnetic Resonance in Medicine, Blackwell Wissenschafts-Verlag Berlin Vienna. - 2001.

Internet resources:

Lectures in electronic format - http://www.gmamin.kpfu.ru

Search system Scopus - http://www.scopus.com/home.url

Website publisher Elsevier - http://elsevierscience.ru/

Center for collective use at KPFU - http://www.kpfu.ru/main_page?p_sub=11446

Electronic journal Physical Review B - http://prb.aps.org/

Course name *Structural and dynamical properties of condensed matters*				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	18 weeks	Optional	2	In-class- 26, independent - 46

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	Exam	Lectures, practical lessons	V.D. Skirda

Educational outcomes

As a result of the discipline acquisition a student:

1. must:

- understand the basic results of the translational dynamics of molecules and macromolecules in the most representative classes of molecular systems (polymer, heterogeneous, etc.);

2. must be able to:

- compare various characteristics of the molecular system, obtained by different methods or different techniques within one method;

3. must have:

- skills of primary analysis of experimental results and their comparison with theoretical calculations or models.

4. must demonstrate the ability and readiness to:

-Examine experimental data and theoretical approaches in the relationship;

-critically evaluate the existing approaches in the literature;

-build logical evidence and justification of a hypothesis with a complete an analysis of alternatives;

-organize and plan physical studies;

-independently set specific tasks of scientific research in the field of physics (according to the profile of the master's program) and solve them with the help of modern equipment, hardware, information technology using the latest domestic and foreign experience.

Contents
Topic 1. Structure and dynamics of molecules in solutions and polymer melts lecture (3 hours), practical lesson (4 hours): Topic 2. Features of molecular mobility and supramolecular structures in three-dimensional macromolecular systems lecture (3 hours), practical lesson (2 hours): Topic 3. Dynamics of multiphase systems with phase separation lecture (2 hours), practical lesson (2 hours): Topic 4. The phase state and dynamics of molecules in limited environments lecture (4 hours), practical lesson (4 hours): Topic 5. Features of structural and dynamic characteristics in biosystems lecture (2 hours):

Exemplary literature
Main literature: 1. The spectral analysis methods. Practical Guide: Study guide / V.I. Vasiliev, O.F. Stoyanova, I.V. Shkutin, R.I. Karpov. - 2014. - 416 p. – First edition. - ISBN 978-5-8114-1638-7. - Publisher "Lan". Electronic library system. http://e.lanbook.com/books/element.php?pl1_id=50168 2. Nuclear magnetic resonance in inorganic and coordination chemistry. Mortars and liquid / M.A. Fedotov - 2010. - ISBN: 978-5-9221-1202-4. - 384 p. - Publisher "FIZMATLIT." Electronic library systemc. 3. Nuclear magnetic resonance in inorganic and coordination chemistry. Mortars and liquid / M.A. Fedotov - 2010. - ISBN: 978-5-9221-1202-4. - 384 p - Publisher "FIZMATLIT." Electron library sisTopic. http://e.lanbook.com/books/element.php?pl1_id=2151 Additional literature: 1. Phase transitions of polymer systems in external fields: Study guide / R.A. Vshivkov.- 2nd edition, revised and updated. - 2013.- 368 p. - ISBN 978-5-8114-1529-8. - Publisher "Lan" Electronic Library system. http://e.lanbook.com/books/element.php?pl1_id=30431 2. Nuclear Physics. The theoretical basis and laboratory practice: study guide / V.E. Grakov, R.A. Maskevich, et. al.; Under ed. of A.P. Klischenko. - M.: INFRA-M; Mn .: New Knowledge, 2011. - 333p. http://znanium.com/bookread.php?book=218015#none Internet resources: Diffusion NMR, User Manual, Bruker BioSpin, This manual was written by Klaus Zick. This manual was edited by Stanley J. Niles - December 2, 2009: Bruker Biospin GmbH Rheinstetten, Germany P / N: H9153 DWG-Nr .: 1453003 - http://www.rit.edu/cos/scms/pdf/500MHz -NMR / diffusion-manual.pdf Fundamentals of NMR (Chapter 1) THOMAS L. JAMES (Department of Pharmaceutical Chemistry, University of California, San Francisco, CA 94143-0446 USA) - http://www.ias.ac.in/initiat/sci_ed/resources/chemistry /James.T.pdf NMR Relaxation. Phenomenology and Experimental Considerations. Review of First-Order Rate Kinetics - https://wasatch.biochem.utah.edu/nmr/NMR%20Relaxation%20Basics.pdf Solution Dynamics and Self-OrganizationProfessor, William S. Price - http://www.uni-leipzig.de/diffusion/powerpoint_presentations/pdf/price.pdf

BASES of X-ray analysis - http://ssrc.inp.nsk.su/CKP/lectures/X-ray_structure_analysis.pdf

Course name *The mechanisms of magnetic relaxation*				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	14 weeks	Optional	2	In-class- 26, independent - 46

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	Exam	Lectures, practical lessons	A.V. Duglav

Educational outcomes
As a result of the discipline acquisition a student: 1. must know: The basic mechanisms and processes of the electron and nuclear spin-lattice relaxation. 2. must be able to: Evaluate speed of the nuclear and electronic relaxation due to different relaxation processes. 3. must have: methods of calculation of the spin-lattice relaxation in the various relaxation mechanisms 4. must demonstrate the ability and readiness for: Deep self-study of emerging approaches to the study of the mechanisms and processes of magnetic relaxation.

Contents
Topic 1. Introduction. The spin-lattice relaxation and the opportunity to observe the resonance. lecture (1 hours), practical lesson (1 hours): Topic 2. The relaxation due to the interaction of the spins with the field of thermal electromagnetic radiation. lecture (1 hours), practical lesson (1 hours): Topic 3. Relaxation through interaction with the phonon field. lecture (2 hours), practical lesson (1 hours): Topic 4. The phenomenon of phonon bottleneck.

lecture (1 hours), practical lesson (1 hours):

Topic 5. The nuclear spin-lattice relaxation in dielectric diamagnetic crystals, due to the modulation of gradient of the CEP.

lecture (2 hours), practical lesson (2 hours):

Topic 6. The nuclear spin-lattice relaxation in crystals caused by isolated impurity of paramagnetic centers.

lecture (2 hours), practical lesson (2 hours):

Topic 7. The nuclear spin diffusion. Nuclear relaxation via paramagnetic centers in the absence of nuclear spin diffusion. Relaxation through dipole-dipole reservoir of paramagnetic impurities.

lecture (1 hours), practical lesson (1 hours):

Topic 8. DNP diamagnetic atoms in solid dielectrics.

lecture (2 hours), practical lesson (2 hours):

Topic 9. The nuclear spin-lattice relaxation in metals.

lecture (2 hours), practical lesson (1 hours):

Exemplary literature

Main literature:

1. N.A. Sergeev. Principles of Quantum theory of nuclear magnetic resonance: monograph / N.A. Sergeev, D.P. Ryabushkin. - Moscow: Logos, 2013. - 272 p. - ISBN 978-5-98704-754-5 http://znanium.com/bookread.php?book=469025

2. N.I. Minko. Methods of preparation and properties of nano-objects [Electronic resource]: study guide / N.I. Minko, V.V. Strokova, I.V. Zhernovskiy, V.M. Nartsev. - 2nd ed., - M .: Flint, 2013. - 165 p. - ISBN 978-5-9765-0326-7. http://znanium.com/bookread.php?book=462886

3. V.F. Traven. Organic Chemistry. Volume 2 [Electronic resource]: Study guide for HEIs: 3 volumes / V.F. Traven. - 3rd ed. (el.). - M.: BINOM. Knowledge Laboratory, 2013. - 517 p.: image. - (The textbook for high school). - ISBN 978-5-9963-2110-0 (T. II), ISBN 978-5-9963-0357-1. http://e.lanbook.com/books/element.php?pl1_id=8693

Additional literature:

1. A. Abraghm, B.Blini. Electron paramagnetic resonance of transition ions. M .: Mir, 1973. Vol.1.

2. A. Abraham. Nuclear Magnetism. M .: IL, 1963.

3. A. Abraham, M.Goldman. Nuclear Magnetism: Order and Disorder. M .: Mir, 1984, Volume 2

4. Ch. Slikter. Fundamentals of the theory of magnetic resonance. M .: Mir, 1981.

5. A.G. Gurevich. Magnetic resonance in ferrites and antiferromagnets. M .: Nauka, 1973.

6. R.A. Altshuler, B.M. Kozyrev. Electron paramagnetic resonance of compounds of elements of intermediate groups. M.: Nauka, 1972.

7. K. Dzheffrip. Dynamic nuclear orientation. M : Mir, 1965.

8. Ch. Kittel. Introduction to Solid State Physics. M.: Nauka, 1978.

Internet resources:

Wikipedia - http://ru.wikipedia.org

Everything for students - http://www.twirpx.com/

Scientific Library named after Lobachevsky - http://www.kpfu.ru/main_page?p_sub=5056

Electronic library system - http://ibooks.ru
EBooks - http://eknigi.org/

Course name ***Quantum theory of magnetism***				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	14 weeks	По выьору	4	In-class- 26, independent - 82

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	Exam	Lectures, practical lessons	D.A. Tayurskiy

Educational outcomes

As a result of the discipline acquisition a student:

1. must know:

- Modern theoretical level description of the magnetic properties of condensed matter;

- Theoretical foundations of modern experimental research methods in the field of magnetism of condensed matter;

- The main classical and contemporary experimental data on the magnetic properties of solids.

2. must be able to:

- apply modern methods of theoretical study of magnetism of condensed matter for the calculation of the magnetic susceptibility and the magnetization of the magnetic moments systems.

3. must have:

- The skills of scientific analysis of the problems of the system (both natural and professional) of various levels of complexity;

- Skills to work with the basic theoretical methods in the field of condensed matter physics and magnetism and with the modern scientific literature.

4. must demonstrate the ability and readiness:

- To use the gained knowledge to describe real physical systems

Contents

Topic 1. The magnetic moments.

lecture (2 hours), practical lesson (2 hours):

Topic 3. The magnetic properties of the system of non-interacting localized moments.

lecture (2 hours), practical lesson (2 hours):

Topic 4. The magnetic properties of systems of weakly interacting localized moments.

lecture (2 hours), practical lesson (2 hours):

Topic 5. The magnetism of strongly interacting systems moments.

lecture (4 hours), practical lesson (3 hours):

Topic 6. The magnetic properties of the systems with magnetic impurities.

lecture (2 hours), practical lesson (2 hours):

Topic 7. Spin glasses.

lecture (2 hours), practical lesson (1 hours):

Exemplary literature

Main literature:

1. A.A. Abrikosov. Fundamentals of the theory of metals. M. FIZMATLIT. - 2010. - 600 p.

http://e.lanbook.com/view/book/2093/

2. R.V. Borisenok, A. R. Kondratie. Quantum statistical mechanics. M .: FIZMATLIT 2011.

- 136 p. http://e.lanbook.com/view/book/2672/

3. The course of general physics. 5 volumes. Volume 5. Quantum Optics. Atomic physics. Solid State

body. Physics of an atomic nucleus and elementary particles. “Lan”. - 2011. - 384 p.

http://e.lanbook.com/books/element.php?pl1_id=708

4. V.L. Matukhin, V.L. Ermakov, Solid State Physics. Publisher: "Lan", 2010, 224 p.

http://e.lanbook.com/books/element.php?pl1_id=262

Additional literature:

Lectures on magnetism, E.R. Borovik; V.V. Eremenko; A.R. Milner, 2005.

Electricity and Magnetism, A.N. Matveev, 2010.

1. L.K. Aminov. The dynamics and kinetics of electron and spin excitations in paramagnetic crystals / L.K. Aminov, B.Z. Malkin. - Kazan: Kazan state university Press, 2008. - 217 p.

http://kpfu.ru/docs/F1917339624/DynamicsSpinParamagnets_Aminov_Malkin.pdf

Internet resources:

Joint Quantum Institute - http://jqi.umd.edu/

Institute for Theoretical Physics named after L.D. Landau. Sector of Quantum mesoscopics - http://qmeso.itp.ac.ru/

Bonded magnets and magnet systems - http://www.valtar.ru/index.htm

Science and Life - http://www.nkj.ru/

Physics encyclopedia - http://www.femto.com.ua/index1.html

Course name ***Quantum technologies***				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	13 weeks	Optional	4	In-class- 30, independent - 42

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	Exam	Lectures, practical lessons	D.A. Taurskiy

Educational outcomes

As a result of the discipline acquisition a student:

1. must know:

- The current state of theoretical developments and the main experimental results and achievements in the field of quantum technologies, principles of nano- and mesoscopic devices

2. must be able to:

- Explain the quantum size effects, analyze current scientific literature, use the knowledge of theoretical methods to explain the experimentally observed regularities

3. must have:

- Skills of the analysis of experimental facts and laws, methods of formulating and solving simple problems in the field of quantum technologies

4. must demonstrate the ability and readiness for:

- Further training, conduct of independent research and innovation, creative participation in engineering and technology projects

Contents

Topic 1. Introduction. Quantum technologies: second quantum revolution

lecture (2 hours), practical lesson (2 hours):

Topic 2. The topological insulators and superconductors. Dirac fermions and Majorana fermions with condensed matter physics and quantum devices.

lecture (2 hours), practical lesson (4 hours):

Topic 3. Ultracold quantum gases

lecture (4 hours), practical lesson (4 hours):

Topic 4. Quantum entanglement of quantum states and invisibility

lecture (2 hours), practical lesson (2 hours):

Topic 5. Quantum interferometry

lecture (2 hours):

Topic 6. Quantum Biology

lecture (2 hours):

Exemplary literature
Main literature: 1. R.R. Aplesnin. Basics of spintronics. SPb.: „Lan“, 2010. - 288 p. http://e.lanbook.com/view/book/551/ ELS "Lan" 2. A.A. Barybin, V.I. Tomilin, V.I. Shapovalov. Physical and technological bases of macro, micro and nanoelectronics. - M.: FIZMATLIT, 2011. - 784p. http://e.lanbook.com/view/book/5258 / ELS "Lan" 3. A.I. Guse. Nanomaterials, nanostructures, nanotechnology / A.I. Gusev. - 2nd edition, revised. - M.: FIZMATLIT, 2009. - 416 p. http://e.lanbook.com/books/element.php?pl1_id=2173 ELS "Lan" Additional literature: 1. R.V. Borisenok, A.R. Kondratiev. Quantum statistical mechanics. M.: FIZMATLIT, 2011. -136 p. http://e.lanbook.com/view/book/2672/ ELS "Lan" 2. V.L. Matukhin, V.L. Ermakov. Solid State Physics. - M .: "Lan", 2010. - 224 p. http://e.lanbook.com/view/book/262/ ELS "Lan" 3. AN Ignatov, Microcircuitry and nanoelectronics. - "Lan", 2011. - 528 c. http://e.lanbook.com/view/book/2035/ ELS "Lan" Internet resources: Single window access to educational resources. Library - http://window.edu.ru/library nanotech community nanometer - http://www.nanometer.ru The new e-library - http://www.newlibrary.ru ELS KnigaFund - http://www.knigafund.ru Electronic archive of scientific preprints in physics - http://arxiv.org

Course name ***Modern methods of optical spectroscopy***				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	15 weeks	Optional	3	In-class- 26, independent - 82

Enrollment requirements	Exam type (oral, written, course work, etc.)	Educational methods (lectures, seminars, etc.)	Course coordinator
	exam	Lectures, practical lessons	R.V. Yusupov

Educational outcomes
1. must know: - Theory and principles, on the bases of which are conducted experimental research methods of linear and nonlinear optical spectroscopy, laser spectroscopy, high spectral and temporal resolution; 2. must be able to: - Understand, describe and critically analyze the basic general physical information; - Use the theoretical basics, the basic concepts and laws in the field of optical spectroscopy; - Be aware of the advantages and disadvantages of various methods for the adequate choice for solving specific problems; 3. must have: - Skills to conduct experiments in the field of advanced optical spectroscopy to address specific scientific and technological problems; 4. must demonstrate the ability and readiness to: - Use of optical spectroscopy techniques learned in the preparation of final qualifying works;

Contents
Topic 1. Properties of optical radiation. Overview of modern methods of optical spectroscopy. Lasers as a source of radiation opening fundamentally new opportunities in optical spectroscopy. lecture (2 hours): Topic 2. Methods of intracavity selection of the radiation spectrum. Schemes of resonators with different intracavity dispersion elements: prisms, diffraction gratings, Fabry-Perot etalons, Lio filters, acousto-optic selectors. Features of continuous and pulsed tunable lasers. lecture (2 hours): Topic 3. Active frequency stabilization of the laser. Stabilization of the Fabry-Perot interferometer. Stabilization of saturated absorption resonances. lecture (2 hours): Topic 4. The principles of laser systems range of ultrashort duration of the output pulses. Generators of ultrashort pulses (USP) with a fixed wavelength. Tunable ultrashort pulse. lecture (2 hours), practical lesson (4 hours): Generators of ultrashort pulses (USP) with a fixed wavelength. Tunable ultrashort pulse. Nonlinear optical compressors USP. Topic 6. Methods of nonlinear frequency conversion.

lecture (2 hours):

Topic 7. Fundamentals of intracavity spectroscopy. Applications of intracavity spectroscopy.

Topic 8. Laser Raman spectroscopy. Stimulated Raman scattering. Spectroscopy of coherent anti-Stokes Raman scattering. Applications of laser Raman spectroscopy.

Topic 9. Fundamentals and applications of selective laser spectroscopy.

practical lesson (8 hours):

Topic 10. Multiphoton Spectroscopy. The probability of multiphoton transitions. The use of multiphoton absorption in spectroscopy and atomic crystals.

lecture (2 hours):

Topic 11. The method of double resonance. Optical detection of the EPR.

Topic 12. High-resolution sub-Doppler spectroscopy.

Topic 13. Laser spectroscopy with a time resolution. Picosecond and femtosecond spectroscopy. Pump-probe method.

Lecture (2 hours):

Exemplary literature
Main literature: 1. V. Demtreder. Modern laser spectroscopy (study guide) / V.Demtreder (trans. from English) - Dolgoprudny: Intelligence, 2014. - 1071 p. 2. B. Salekh, M. Teykh. Optics and photonics. Principles and Applications: Study guide, 2 volumes, Vol. 1: Dolgoprudny, Ltd. publishing house "Intelligence", 2012. - 760 p. 3. B. Salekh, M. Teykh. Optics and photonics. Principles and Applications: Study guide, 2 volumes, Vol. 2: Dolgoprudny, Ltd. publishing house "Intelligence", 2012. - 764 p. Additional literature: 1. Physics of lasers / O. Zvelto. Trans. under the scientific. ed. of T.A. Shmaonov, Publishing house "Lan", 2008. - 720 p. 2. R.P. Anokhov, T.Ya. Marusiy, M.R. Soskin. Tunable lasers. M.: Radio and Communications, 1982. - 359 p. Internet resources: Wikipedia, the free encyclopedia - http://ru.wikipedia.org/ Everyting for students - http://www.twirpx.com/ Scientific Library named after Lobachevsky - http://www.kpfu.ru/main_page?p_sub=5056 Electronic library system - http://ibooks.ru EBooks - http://eknigi.org/

Course name *Laser spectroscopy*				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	15 weeks	Optional	3	In-class- 26, independent - 82

Enrollment requirements	Exam type (oral, written, course work, etc.)	Educational methods (lectures, seminars, etc.)	Course coordinator
	Exam	Lectures, practical lessons	R.I. Nikitin

Educational outcomes
1. must know: - Theory and principles, which are conducted on the basis of experimental research methods of linear and nonlinear laser spectroscopy; 2. must be able to: - Understand, present and critically analyze the basic general physical information; - Use the theoretical basics, the basic concepts and laws in the field of laser spectroscopy; be aware of the advantages and disadvantages of various methods for the adequate choice for solving specific problems; 3. must have: - Skills to conduct experiments in the field of laser spectroscopy to address specific scientific and technological problems 4. must demonstrate the ability and readiness to: - Use laser spectroscopy techniques learned in the performance of final qualifying works

Contents
Topic 1. The properties of laser radiation. Lasers as a source opening up entirely new possibilities in optical spectroscopy. lecture (2 hours): Topic 2. The active medium for tunable lasers: solutions of organic dye crystals activated by ions of the iron group and rare-earth ions (df transitions), crystals with color centers. lecture (2 hours): Topic 3. Methods of intracavity selection of the radiation spectrum. Schemes of resonators with different intracavity dispersion elements: prisms, diffraction gratings, Fabry-Perot etalons, Lio filters, acousto-optic selectors. Features of continuous and pulsed tunable lasers. Schemes with longitudinal and transverse pumping of the active medium. Lasers with distributed feedback. lecture (2 hours): Topic 4. Active frequency stabilization of the laser. Stabilization of the Fabry-Perot interferometer. Stabilization of saturated absorption resonances. lecture (2 hours): Topic 5. Principles of ultrashort laser systems range. Generators of ultrashort pulses (USP) with a fixed wavelength. Tunable ultrashort pulse. Nonlinear optical compressors USP.

practical lesson (4 hours):

Topic 6. Methods of nonlinear frequency conversion.

lecture (2 hours):

Topic 7. Fundamentals of intracavity spectroscopy. Applications intracavity spectroscopy.

Topic 8. Laser Raman spectroscopy. Stimulated Raman scattering. Spectroscopy of coherent anti-Stokes Raman scattering. Applications of laser Raman spectroscopy.

Topic 9. Fundamentals and applications of selective laser spectroscopy.

practical lesson (8 hours):

Topic 10. Multiphoton spectroscopy. The probability of multiphoton transitions. The use of multiphoton in absorption spectroscopy and atomic crystals.

lecture (2 hours):

Topic 11. The method of double resonance. Optical detection of the EPR.

Topic 12. High-resolution sub-Dopler spectroscopy.

Topic 13. Laser spectroscopy with a time resolution. Picosecond and femtosecond spectroscopy. Pump-probe method.

lecture (2 hours):

Exemplary literature

Main literature:

1. V. Demtreder. Modern laser spectroscopy (study guide) / V.Demtreder (trans. from English) - Dolgoprudny: Intelligence, 2014. - 1071 p.

2. B. Salekh, M. Teykh. Optics and photonics. Principles and Applications: Study guide, 2 volumes, Vol. 1: Dolgoprudny, Ltd. publishing house "Intelligence", 2012. - 760 p.

3. B. Salekh, M. Teykh. Optics and photonics. Principles and Applications: Study guide, 2 volumes, Vol. 2: Dolgoprudny, Ltd. publishing house "Intelligence", 2012. - 764 p.

Additional literature:

1. Physics of lasers / O. Zvelto. Trans. under the scientific. ed. of T.A. Shmaonov, Publishing house "Lan", 2008. - 720 p.

2. R.P. Anokhov, T.Ya. Marusiy, M.R. Soskin. Tunable lasers. M.: Radio and Communications, 1982. - 359 p.

Internet resources:

Wikipedia, the free encyclopedia - http://ru.wikipedia.org/

Everyting for students - http://www.twirpx.com/

Scientific Library named after Lobachevsky - http://www.kpfu.ru/main_page?p_sub=5056

Electronic library system - http://ibooks.ru

EBooks - http://eknigi.org/

Course name ***Cooperative and coherent phenomena***				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	10 weeks	Optional	2	In-class- 24, independent - 48

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	Exam	Lectures	R.V. Yusupov

Educational outcomes
As a result of the discipline acquisition a student: 1. must know: - Modern theoretical level of description of cooperative phenomena - Experimental methods of research; - Theoretical methods of description. 2. must be able to: apply modern methods of analysis, including the calculation of the dependency of order parameters on temperature. 3. must have: - Skills of the system of scientific analysis of the problems of different levels of complexity; - Skills to work with basic theoretical methods of quantum description in mean-field approximation. must demonstrate the ability and readiness for: further education

Contents
Topic 1. Introduction to the subject. lecture (2 hours): Topic 2. The equilibrium phase transitions. lecture (4 hours), laboratory work (4 hours): Topic 3. The classical theory of phase transitions. lecture (4 hours): Topic 4. The kinetics of phase transitions. laboratory work (4 hours):

Topic 5. The nonequilibrium phase transitions and dissipative structures.

lecture (2 hours), laboratory work (4 hours):

Topic 6. The thermodynamics of nonequilibrium nonlinear systems.

Exemplary literature

Main literature:

1. M.V. Eremin. Microscopic model in condensed matter. Toolkit, KFU. 2011.

2. L.I. Kveglis. Dissipative structures in thin nanocrystalline films [Electronic resource]: monograph / L.I. Kveglis, V.B. Kashkin; Ed. by V.F. Shabanov. - Krasnoyarsk: Sib. Feder. University Press, 2011. - 204 p. - ISBN 978-5-7638-2101-7.

http://znanium.com/catalog.php?bookinfo=441845

3. R.I. Kuznetsov. Elements of physical kinetics. The course in Physics with examples of problem solving [Electronic resource]: Study guide / R.I. Kuznetsov, V.V. Kaplin, R. R. Uglov; Tomsk Polytechnic University. - Tomsk: Publishing house of Tomsk Polytechnic University, 2011. - 77 p. – Access mode:

http://znanium.com/catalog.php?bookinfo=417642

Additional literature:

Non-equilibrium statistical mechanics, I.R. Prigogin, 2005.

Order out of chaos, I.R. Prigogin, Stengers, Isabelle, 2005.

1. L.D. Landau. The course of theoretical physics. V. 9. Statistical Physics [Electronic resource] / L.D. Landau, E.M. Lifshitz, L.P. Pitaevskii; M.: FIZMATLIT, 2001. - 616 p. Access mode: http://e.lanbook.com/books/element.php?pl1_id=2230

2. L.D. Landau. The course of theoretical physics. V. 9. Statistical Physics. Part 2. The theory of condensed state [Electronic resource] / L.D. Landau, E.M. Lifschitz; M.: FIZMATLIT, 2004. - 496 p. Access mode: http://e.lanbook.com/books/element.php?pl1_id=2235

Internet resources:

Wikipedia, the free encyclopedia - http://www.wikipedia.org/

ELS ZNANIUM.COM - http://www.znanium.com/

ELS Bibliorossika - http://www.bibliorossica.com

ELS Publishing House “Lan” - http://e.lanbook.com

ELS Consultant for a student - http://studmedlib.ru

Course name *The theory of phase transitions in condensed matter*

Semester	Duration	Course type	Credits	Student workload
1	10 weeks	Optional	2	In-class- 30, independent - 42

Enrollment requirements	Exam type (oral, written, course work, etc.)	Educational methods (lectures, seminars, etc.)	Course coordinator
	Exam	Lectures	B.M. Khasanov

Educational outcomes
As a result of the discipline acquisition a student: 1. must know: - Landau theory of phase transitions, fundamentals of the fluctuation theory of phase transitions 2. must be able to: - Apply methods of mean field theory and fluctuation in condensed matter physics 3. must have: - Computation skills (within the fluctuation theory)of various properties of condensed systems 4. must demonstrate the ability and readiness for: further education

Contents
Topic 1. Basic principles of statistical physics, basic concepts lecture (2 hours), laboratory work (1 hours): Topic 2. The method of molecular field. Lattice gas. lecture (2 hours), laboratory work (1 hours): Topic 3. Examination №1 (for Topics 1,2) laboratory work (2 hours): Topic 4. The phenomenological theory of Landau lecture (2 hours), laboratory work (1 hours): Topic 5. The role of fluctuations. Ginzburg criterion. lecture (2 hours), laboratory work (1 hours): Topic 6. Examination №2 (for Topics 4,5) laboratory work (2 hours): Topic 7. Kadanov scale transformation. Scaling relations. lecture (2 hours), laboratory work (1 hours): Topic 8. The method of the renormalization group. lecture (1 hours), laboratory work (1 hours): Topic 9. Critical exponents in the approximation of Wilson. lecture (1 hours), laboratory work (1 hours): Topic 10. Examination №3 (for Topics 7-9)

laboratory work (1 hours):

Exemplary literature
Main literature: 1. R.V. Borisënok, A.R. Kondratiev. Quantum statistical mechanics. M.: FIZMATLIT, 2011. -136 p. http://e.lanbook.com/view/book/2672/ 2. B.M. Khasanov. Problems in the physics of phase transitions (study guide). - 2013 - Kazan. - KPFU. - 17 p. http://kpfu.ru/docs/F129716669/Zadachi_po_fizike_fazovih_perehodov.pdf 3. Yu.A. Baikov. Condensed Matter Physics. - M.: Binom. Knowledge Laboratory, 2011. - 293 p. http://e.lanbook.com/view/book/4372/ Additional literature: 1. M.V. Eremin. Microscopic model in condensed media // Study guide. - Kazan: Kazan (Volga region) Federal University, 2011. - 113p. http://kpfu.ru/docs/F1043614157/Eremin_Posobie_2011.doc 2. I.I. Novikov. Thermodynamics. - M.: Publishing House "Lan", 2009. - 592 p. http://e.lanbook.com/books/element.php?pl1_id=286 Internet resources: teaching materials of the department of TP - http://www.kpfu.ru/main_page?p_sub=8205 The new e-library - http://www.newlibrary.ru The educational project of A.N. Vargin - http://www.ph4s.ru/index.html website of the Department of Theoretical Physics - http://www.kpfu.ru/main_page?p_sub=5721 ELS KnigaFund - http://www.knigafund.ru

Course name *Research work*				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	16 weeks	compulsory	7.5	In-class- 55, independent - 809

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	exam	Practical lessons	N.V. Boltakova

Educational outcomes
As a result of the discipline acquisition a student: 1. must know: - Courses of basic physics, mathematics, fundamentals of information technology 2. must be able to: - Find information on the topic of the thesis, perform calculations, process data and report results 3. must have: - The skills of analytical and numerical calculations, modern information technologies 4. must demonstrate the ability and readiness to: present the results of scientific work

Contents
Topic 1. Research work on the master's thesis practical lesson (19 hours): Topic 2. Research work on the master's thesis practical lesson (17 hours): Topic 3. Research work on the master's thesis practical lesson (19 hours):

Exemplary literature
Main literature: 1. Yu.N. Novikov. Preparation and defense of Master's theses and undergraduate work / Publisher: "Lan", 2014 - 32 p. http://e.lanbook.com/books/element.php?pl1_id=4630 2. Master's thesis: Methods and organization of studies, registration and defense: Study guide for students [to undergraduates] / ed. by V.I. Belyaev - Moscow: KnoRus, 2012 - 261 p.: image. ; 21. 3. Guidelines for the implementation of the master's thesis: coursework and projects in the major, scientific research, training, design and defense of final qualifying work / N.A. Belov, M.V. Pikunov, R.V. Laktionov // Moscow: "MISA". - 2013. - 105 p. http://e.lanbook.com/view/book/47415/ Additional literature: 1. Preparing, writing and design of scientific reports: study guide / [Ed.: Assoc. PhD R.M. Khusainov, Assoc. PhD R.M. Khusainova] - Kazan: KSTU, 2009 .- 111 p. 2. Toolkit for the preparation, writing and design of the master's thesis: / [Ed.: A. R. Borisov, Z.M. Slepak] - Kazan [KFU] 2013. Internet resources LATEX - https://ru.wikipedia.org/wiki/LaTeX Conferences of KFU - http://kpfu.ru/science/konferencii/perechen-nauchno-tehnicheskih-

meropriyatij-kfu Report on R&D - http://protect.gost.ru/document.aspx?control=7&id=130946 Package beamer Feature Focus by F.Ya.Halili - http://www.osc.phys.msu.ru/mediawiki/upload/Khalili/example10.pdf Rules for design of list of literature sources - http://protect.gost.ru/document.aspx?control=7&id=129865 Site of Moscow State University - http://master.cmc.msu.ru/?q=node/96 Creating a presentation in Power Point - http://www.google.com/url?sa=t&rct=j&q=powerpoint&source=web&cd=6&ved=0CFEQtwIwBQ&url=http%3A% Creating a presentation using LaTeX. Beamer - http://habrahabr.ru/post/145523/

Course name *Practical training (teaching)*				
Semester	**Duration**	**Course type**	**Credits**	**Student workload**
1	17 weeks	compulsory	3	In-class- 17 independent - 91

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	Exam	Practical lessons	V.V. Parfenov

Educational outcomes
As a result of the discipline acquisition a student: 1. must know: - Modern methods and principles of pedagogical work with students 2. must be able to: - Organize educational work, coordinating, motivating and controlling of the process of teaching students 3. must have: - The skills to conduct seminars 4. must demonstrate the ability and readiness to: - Apply the acquired knowledge in the field of teaching of theoretical physics;

- Analyze teaching methods used by other teachers in the training of this group of students;
- Apply the knowledge acquired at the university in solving practical problems of teaching;
- Independently develop a program of seminars, conduct seminars and workshops;
- Prepare their own teaching materials for classes;
- Formulate the practical problem in the form accessible to students;
- Document the results of completed tasks;
- Search for the necessary additional information data and information on seminars' subjects.

Contents
Topic 1. Introduction stage practical lesson (2 hours): Topic 2. Preparatory stage practical lesson (4 hours): Topic 3. Main stage practical lesson (10 hours): Topic 4. Final stage practical lesson (1 hours):

Exemplary literature
Main literature: 1) Pedagogy and Psychology: Study guide / E.E. Kravtsova. - M.: Forum, 2009. - 384 p.: 60x90 1/16. (Hardcover) ISBN 978-5-91134-301-9, 2000 copies. Access mode: - http://znanium.com/bookread.php?book=164706 2) F.V. Sharipov. Pedagogy and psychology of higher education [Electronic resource]: study guide / F.V. Sharipov. - Moscow: Logos, 2012. - 448 p. - (New university libraries). - ISBN 978-5-98704-587-9. Access mode: - http://znanium.com/bookread.php?book=469411 3) Psychology and Pedagogy: Textbook / A.I. Kravchenko. - M.: INFRA-M, 2013. - 400 p.: 60x90 1/16. - (Higher Education). (Hardcover) ISBN 978-5-16-003038-8, 3000 copies. Access mode: - http://znanium.com/bookread.php?book=394126 7.2. Additional literature: 1) Psychology and Pedagogy: Textbook. Manual / E.V. Ostrovskiy, L.I. Chernyshova. - M.: University textbook: SIC INFRA-M, 2013. - 381 p.: 60x90 1/16. (Hardcover) ISBN 978-5-9558 - 0025-7, 550 copies. Access mode: -http: //znanium.com/bookread.php? Book = 398710 2) Educational Psychology: Study guide / A.N. Fominova, T.L. Shabanovs. - 2-e ed., Rev. and add. - Flint M.: Nauka, 2011. - 320 p.: 60x88 1/16. (Hardcover) ISBN 978-5-9765-1011-1, 1000 copies. Access mode: -http: //znanium.com/bookread.php? Book = 304087 3) I.V. Novgorodtseva. Pedagogy with the methodology of teaching special subjects [Electronic resource]: study guide of modular type / author I.N. Novgorodtseva. - 2nd ed., stereotype. - M. Flint, 2011. - 378 p. - ISBN 978-5-9765-1280-1 Access mode: -http: //znanium.com/bookread.php? book = 454525

4) Educational Psychology: Study guide / B.R. Mandel. - M.: Course: SIC Infra-M, 2012. - 368 p.: 60x90 1/16. (Hardcover) ISBN 978-5-905554-13-1, 500 copies. Access:

-http: //znanium.com/bookread.php? book = 306830

5) Psychological tasks for the period of teaching practice. Part 1 [Electronic resource]: study guide / Ed. by E.A. Silina. ? 2nd ed., M. Flint, 2013. - 63 p. - ISBN 978-5-9765-1794-3. Access mode:

-http: //znanium.com/bookread.php? book = 462995

7.3. Internet resources:

Library of scientific papers, abstracts and theses topics on pedagogical and psychological sciences - http://nauka-pedagogika.com/

V.A. Ivanov, T.V. Levin. Pedagogy. Teaching Materials - http://www.kgau.ru/distance/mf_01/ped-asp/index.html

Electronic Library system Znanium.com - http://znanium.com/

Electronic Library system of Publishing house ?Lan? - Http://e.lanbook.com/

Electron library system “BiblioRossika” - http://www.bibliorossica.com/