DISCIPLINES SUMMARY

Physics of Magnetic Phenomena

Course name: Foreign Language for Specific Purposes				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
2	18 weeks	Compulsory	3	In-class - 36 Self-study 36

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	Exam	Practices	A.V. Fakhrutdinova

Learning outcomes

As a result of the discipline acquisition a student:
1. must know:
Rules of grammar structures translation while reading business and scientifical literature, possess business and scientific dictionary.
2. must be able to:
Translate, abstract and annotate business and scientific literature, carry on conversations in English on the subject of the discipline.
3. must have:
Written and oral speech while reading business and scientific literature, skills of understanding business and scientific speech in English.
4. must show ability and willingness:
As the result of discipline's acquisition the student s must:
- possess idiomatically limited speech, master neutral style of scientific statement;
- possess skills of everyday speech (standard pronunciation and rhythm of speech) and use them for everyday communication;
- understand oral (monolog and dialogue) on general and specific topics;
- possess actively the most used (basic) grammar and main grammar phenomena, typical for professional speech;
- know basic vocabulary of general language, vocabulary of neutral scientific style, as well as main dictionary of their broad and particular specialty;
- read and understand special literature with dictionary of broad and particular profile of the specialty;
- possess basic concepts of public speech – make statements, reports (with preliminary training).
- participate in topics' discussion, related to the specialty (ask and answer questions);
- possess main skills of writing, necessary for preparation of publications, abstracts and correspondence;
- have an idea of main methods of annotation, abstracting and translation of specialty's literature.

Contents

Contents of the discipline
Topic 1. Introduction to the skills of extended writing and research. Development of phonetic skills
Practice (4 hour(s)):
Topic 2. Using evidence to support your ideas. Development of lexical skills
practice(4 hour(s)):
Topic 3. Structuring your project and finding information. Development of grammar skills
practice(4 hour(s)):
Topic 4. Developing your project. Development of speaking skills
practice(4 hour(s)):
Topic 5. Developing a focus. Communicatory reading of specialty's texts: reading for detail, revision reading, reading for specific information, critical reading.
practice(4 hour(s)):
Topic 6. Introductions, conclusions and definitions. Translation of scientific and research text of specialty from English into Russian.
practice(4 hour(s)):
Topic 7. Incorporating data and illustrations. Writing
practice(6 hour(s)):
Topic 8. Preparing for presentations and editing your work. Translation of scientific and research texts of specialty from English into Russian.
practice(6 hour(s)):

Exemplary literature

Basic literature:
1.Sipols, O.V. Develop Your Reading Skills: Comprehension and Translation Practice. Teaching reading and translation (English): study guide. Moscow: Flinta; Nauka, 2011. – 374 p. - http://znanium.com/bookread.php-book=409896
2. Popova, V.V., Kashirina, E.S. Effective Commenting On The Text. - Moscow: Publishing house: Prometey, 2011. – 49p. - http://www.bibliorossica.com/book.html-currBookId=43563.
Ovchinnikova, I.M., Lebedeva, V.A. BUSINESS COURSE IN ENGLISH FOR THE LINGUISTIC DEPARTMENT: study guide. Moscow: Eurasian Open Institute, 2010. – 303p. - http://www.bibliorossica.com/book.html-currBookId=6084
Additional literature:
1. Ilkina, T.V. and others, Eds Ilkina, T.V. English grammar with case study of writing and speech: study guide. Two books. Book 1. B1-B2 levels. - Moscow: MGIMO – University, 2011. – 252p. - http://www.bibliorossica.com/book.html-currBookId=7183
2. Ilkina, T.V. and others, Eds Ilkina, T.V. English grammar with case study of writing and speech: study guide. Two books. Book 2. B1-B2 levels. - Moscow: MGIMO – University, 2011. – 252p. - http://www.bibliorossica.com/book.html-currBookId=7182
3. Best practices in English for PhD students and external doctorate candidates. / [content by: Bagautdinova, G.A. and Lukina, I.I.]; Kazan State University – Kazan: 2005. - 50 p.
Internet resources:
Articles in Physics - - http://www.nobelprize.org/nobel_prizes/themes/physics/
e-LIBRARY - - www.eLIBRARY.ru
IOP Physics World - - http://www.physicsworld.com
Physics - - http://www.buzzle.com/articles/physics/
BiblioRossika - - http://www.bibliorossica.com/
Publishing house «Lan'» - - http://e.lanbook.com

Course name: Academic Writing				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
1	15 weeks.	compulsory	2	In-class - 36 Self-study 36

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

Learning outcomes

As a result of the discipline acquisition a student:
1. must know:
Tasks and goals of written and scientific communication, peculiarities of scientific style of written and oral texts, ground rules of scientific texts' organization.
2. must be able to:
- keep a record of main thoughts and facts (from audiotexts and texts for reading), as well as a record of abstracts of an oral or written report on studied problematics;
- carry out written project tasks (written design of presentations, research results and so on);
- organize correctly own ideas prove and express them, clearly and conclusively;
3. must have:
- skills of own text analysis,
- technology of academic text's structuring;
- main skills of reading and scientific and research texts creation,
- skills of intelligent work with bibliography, selection of linguistic means, suitable for scientific stlye of speech,
- methods of summary and annotation writing of scientific article, essay, scientific report, grant proposal.
4. must show ability and willingness:
- use skills of writing communication in academic and scientific and technical field while writing scientific and research works.

Contents

Topic 1. Understanding academic convention in English writing
Lecture(2 hour(s)):
practice(2 hour(s)):
Topic 2. The communication range of academic English
Lecture(2 hour(s)):
practice(2 hour(s)):
Topic 3. Organizing the text in academic writing
Lecture(2 hour(s)):
practice(2 hour(s)):
Topic 4. Writing an article: sections overview, content, order of creation. Writing an Introduction

section
Lecture(2 hour(s)):
practice(2 hour(s)):
Topic 5. Writing about methodology. Writing Scientific Visuals & presentations
Lecture(2 hour(s)):
practice(2 hour(s)):
Topic 6. Writing Results and Discussion/Conclusion Sections
Lecture(2 hour(s)):
practice(2 hour(s)):
Topic 7. Writing the Abstract.
Lecture(2 hour(s)):
practice(2 hour(s)):
Topic 8. Referencing and schools of citations
Lecture(2 hour(s)):
practice(2 hour(s)):
Topic 9. Peculiarities of Scientific English: grammar, style, vocabulary, sentence structure and punctuation
Lecture(2 hour(s)):
practice(2 hour(s)):

Exemplary literature

Basic literature
1. Makhmutova, A.N. ACADEMIC WRITING [E-resourse]. Kazan: KFU, 2014. //http://tulpar.kfu.ru/course/view.php?id=520
2. Bagautdinova, G.A., Lukina, I.I. English for PhD students and external doctorate students: Study guide. / Authors Bagautdinova, G.A., Lukina, I.I. – Kazan: KFU, 2012г.- 134p. //http://kpfu.ru/main_page?p_sub=7108
3. Polenova, A.Ju, Chislova A.S. A Complete Guide to Modern Writing Forms. Modern forms of a letter in English. - Moscow: INFRA-M: Akademtsentr, 2012. – 160p. //http://znanium.com/bookread.php?book=235606
4. Stamova, I.I. Writing in English: introduction into practice for students of the first academc year of Faculty for Political Science. / Stamova I.I.. - Moscow: MGIMO – University, 2011. - 83 p. (E-library "Bibliorossika" http://www.bibliorossica.com/book.html?currBookId=7264).
5. Krivoshlykova, L.V. and Nesova, N. M. Passing the qualifying exam for the Candidate degree: Study guide/ Krivoshlykova, L.V. and Nesova, N. M. - Moscow: PFUR, 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 c. (Lobachevsky Research Library).
2. Seely, John. The Oxford guide to writing and speaking / J.Seely . - Oxford ; N.Y. : Oxford Univ. Press, 2000 . - IX,304c. - Ind.: c.297-302 . - ISBN 0-19-280109-0 : 65.00. (Lobachevsky Research Library).
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 с. : ил. ; 26 . - Указ.: с. 167-176 . - ISBN 978-0-521-68939-7 (paperback). (Lobachevsky Research Library).
Internet resources:
Academic writing - study advice (university of Reading) - http://www.reading.ac.uk/internal/studyadvice/studyresources/sta-academic.aspx
Academic Writing Center (HSE) - 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 Philosophical Questions of Natural Science				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
3	16 weeks.	Compulsory	2	In-class- 28 Self-study - 44

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	credit	Lectures, practice	A.S. Nizamutdinov

Learning outcomes

As a result of the discipline acquisition a student:
1. must know:
Main philosophical conceptions, which became a vision basis for Natural Science; philosophical basis of Physics, its main methods; main directions of Natural Science history.
2. must be able to:
Plan the scientific research process, analysi results and predict prospects of scientific directions.
3. must have:
Main paradigms of modern postnonclassical science (relativistic, quantum, fractal) and their methods, necessary for professional activity.
4. must show ability and willingness:
To find a prospective and relevant way of solvinf scientific tasks, of scientific direction

Contents

Topic 1. Tasks of Natural Science. Stages of nature's knowledge. Fundamental and apllied science. Technology. Corpus of Natural Sciences.
Lecture(2 hour(s)):
Topic 2. Methodology of scientific knowledge. Empirical and theoretical knowledge. Cognition. Experiment.
Practice (2 hour(s)):
Topic 3. Global Natural Sciences Revolutions. Science, technology and economics.
Lecture(2 hour(s)):
Topic 4. Urgency of scientific research. Where you can find resources. Models of science economics.
Practice (2 hour(s)):
Topic 5.World systems. Ancient philosophers. Froming of mechanical worldview.
Lecture(2 hour(s)):
Topic 6. Thermodynamic worldview.
Lecture(2hour(s)):

Topic 7. Magneto-electric worldview. Fundamental interactions.
Lecture(2 hour(s)):
Topic 8. Worldviews.
practice(2 hour(s)):
Topic 9. Structure of scientific knowledge. Methods and forms of empiric level. Metods and forms of theoretic level.
Lecture(2hour(s)):
Topic 10. Transfer of technologies. Technological entrepreneurship. Copyright protection.
Lecture(2hour(s)):
practice(4 hour(s)):
Topic 11: Realization project of scientific research. Project your lab. Regulations and standards.
practice(4 hour(s)):

Exemplary literature
Basic literature 1.Philosophy of Science: Study guide for PhD students and external doctorate students / Mareeva, E.V., Mareev, S.N, Maidansky, A.D. Moscow Academy of Economics and Law. Moscow: INFRA-M, 2010. - 333 p.: 60x90 1/16. - (BO). (binding) ISBN 978-5-16-003916-9, 1000 copies. http://znanium.com/bookread.php-book=190229 e-resource 2. History and Philosophy of Science (Philosophy of Science): Study guide / Bel'skaya, E.Ju, Volkova, N.P. and others; edited by Kryaneva, Ju.V., Motorina L.E. - 2 copies, revised and amended. - Moscow: Alfa-M, INFRA-M 2011. - 416 p.: 60x90 1/16. (п) ISBN 978-5-98281-233-9, 1000 copies. http://znanium.com/bookread.php-book=254523 e-resource 3. Zelenov, L.A. History and Philosophy of Science [e-resource]: Study guide. For Master students, external doctorate students and PhD students / Zelenov L.A, Vladimirov, A.A, Shchurov, V.A. – 2nd edition, pattern. - Moscow: Flinta: Nauka, 2011. - 472 p.http://znanium.com/bookread.php-book=406114 e-resource Additional literature 1. Philosophy and Epistemology: Study guide / Leshkevich, T.G. - Moscow: INFRA-M, 2011. – 408 p. http://znanium.com/bookread.php-book=216064 e-resource 2. Koyre A. Galileo and Plato // Outline of History of Philosophy. Moscow,1985. p.128 -153. 3. Koyre A. // Outline of History of Philosophy. Moscow,1985. Newton's hypothesis and experiment. Newton and Descartes // Moscow,1985. p. 175 - 266. 1 Internet resources: Data base of European PTO - http://espacenet.com Wikitextbook Philosophy of Science - http://ru.wikibooks.org/wiki/%D0%A4%D0%B8%D0%BB%D0%BE%D1%81%D0%BE%D1%84%D0%B8% Nature Journal - http://nature.com Philosophy of Science - http://www.filosofium.ru/list.php_c=filnauki Philosophical dictionary. Library of Philosophy - http://filosof.historic.ru/

Course name History and Methodology of Science				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
3	16 weeks.	Compulsory	2	In-class- 28 Self-study - 44

Enrollment requirements	Exam type (oral, written, course work, etc.)	Educational methods (lectures, seminars, etc.)	Course coordinator
	credit	Lectures, practice	A.S. Nizamutdinov

Learning outcomes
As a result of the discipline acquisition a student: 1. must know: Main development directions of natural sciences, radiophysics, including fileds of science and technics, where students will be working after they graduate from their Master's degree. 2. must be able to: Understand and recognize processes in subject areas of their specialty, know how to analyze experimental data, draw conclusions, generalize and forecast. 3. must have: Knowlesge about methodology of physical researches, organization of scientific researches. 4. must show ability and willingness: Put knowledge into practice

Contents
Topic 1. Methodology of science and development history of Physics. *Lecture(2 hour(s)):* *practice(2 hour(s)):* Topic 2. Development history of radiotechnics (from radio valve to transistor and microprocessor). *Lecture(2 hour(s)):* *practice(2 hour(s)):* *practice(2 hour(s)):* Topic 3. Development history of radioastronomy (radar, radar telescope, stellar interferometer) *Lecture(2 hour(s)):* *practice(2 hour(s)):* Topic 4. Development history of quantum electronics (cross section, NMR, lasers) *Lecture(2 hour(s)):* *practice(2 hour(s)):* Topic 5. History of radio set's appliance in Medicine, Biology, Geology, Chemistry, Oil and Gas industry and so on. *Lecture(2 hour(s)):* *practice(2 hour(s)):* Topic 6. Radio techniques. Electron microscope, Ct-scanner and MR-imager, cardiographs. *Lecture(2 hour(s)):* *practice(2 hour(s)):* Topic 7. Ground rules of information data transfer as a stream. Modern communication media. *Lecture(2 hour(s)):* *practice(2 hour(s)):*

Exemplary literature
Basic literature 1. Starzhinsky, V. P. Methodology of science and innovative activity: Guide for PhD students, Master students and external doctorate students. / Starzhinsky, V.P. and Tsepkalo, V.V. - Moscow: Scientific and research center INFRA-M; Novoe Znanie, 2013 – 327p. http://znanium.com/bookread.php-book=391614 2. Kukushkina V.V. Organization of scientific and research work of students (postgraduates): Study guide / kukushkina V.V. - Moscow: Scientific and research center INFRA-M, 2014. – 265p. http://znanium.com/bookread.php-book=405095 3. Concepts of contemporary natural science: Practical course / Romanov V.P. – 3rd edition, edited and amended. - Moscow: HEI textbook: Scientific and research center INFRA-M, 2015. - 128 p. http://znanium.com/bookread.php-book=474514 4. Baturin V.K. Theory and methodology of effective scientific activity [e-resource]: Monograph / Baturin V.K.. - Moscow: HEI textbook: INFRA-M, 2013. - 305 p. http://znanium.com/bookread.php-book=403679 Additional literature 1. Alanasevich P.A. Development of laser physics in Belarus. //UFN, 2004, T. 174, □10, C. 128-1131. 2. Manenkov A.A. On role of paramagnetic resonance in formation and development of qyantum electronics: facts and comment. //UFN, T.176, 2006, №6, C. 669-673. 3. Krokhin O.O. Early years of quantum electronics. //UFN, 2004, T. 174, №10. C. 117-1120. 4. History of physics: translated from Italian / M. Liuzzi.- Moscow: Mir, 1970 .- 464p. - Bibliography: p.450-542. 5. Dorfman Ja. G. World History of Physics. Moscow: Nauka, 1979. 248 p. 6. Development of Physics in Russia. Part 1. Moscow: Prosveshchenie, 1970. 447 p. 7. Folta Ja, Novy L. History of natural sciences in dates. Moscow: Progress. 1987. - 495 p. Internet resources: Big encyclopedia of oil and gas - (http://www.ngpedia.ru/cgi-bin/findimg.exe?reg=1&text=032209245229236224032240229227243235255242238240224032211224242242224046) Wikipedia Radiophysics - http://ru.wikipedia.org/wiki/%D0%E0%E4%E8%EE%F4%E8%E7%E8%EA%E0 History of telegraph - http://www.3dnews.ru/editorial/razgovor_tekstom/ Lecture notes of Radioastronomy - http://heritage.sai.msu.ru/ucheb/Rudnickij/ Museum of Physics' History in Saint-Petersburg University - http://www.phys.spbu.ru/museum/index.php-depts/radio Radiotechnics and Radiophysics - http://historic.ru/books/item/f00/s00/z0000027/st054.shtml Events and dates in history of radionics - http://www.rzi.tusur.ru/wp-content/uploads/2013/04/sidir.pdf

Course name Mathematical methods of experimental data processing				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
1	15 weeks.	Compulsory	3	In-class- 39 Self-study - 69

Enrollment requirements	Exam type (oral, written, course work, etc.)	Educational methods (lectures, seminars, etc.)	Course coordinator
	credit	Lectures, practice	Егоров А.В.

Learning outcomes
As a result of the discipline acquisition a student: 1. must know: - Strategy of methods' construction of experimental statistics; - limitation and conditions of appliance of different methods' groups of data processing; - terminology of mathematical statistics and theory of signal processing; 2. must be able to: Analize experimental results 3. must have: - skills of realization of most routine methods of statistical data processing; - skilles of interpretation of findings; 4. must show ability and willingness: Chosinf methods, most appropriate for experimental conditions; Interpretation of findings.

Contents
Contents of the discipline Topic 1. Main model distributions. *Lecture(2 hour(s)):* *practice(4 hour(s)):* Topic 2. Hyphothesis testing. *Lecture(2 hour(s)):* *practice(4 hour(s)):* Topic 3. Hyphothesis testing *Lecture(2 hour(s)):* *practice(4 hour(s)):* Topic 4. Non-parametric test. *Lecture(2 hour(s)):* *practice(4 hour(s)):* Topic 5. Regression analysis. *Lecture(2 hour(s)):* *practice(4 hour(s)):* Topic 6.Regression analysis *Lecture(2 hour(s)):* *practice(4 hour(s)):* Topic 7. Regression analysis *Lecture(1 hour(s)):* *practice(2 hour(s)):*

Exemplary literature
Basic literature 1. Theory of chances and mathematical statistics: Textbook / Kochetkov E.S., Smerchinskaya S.O., Sokolov V.V. – 2nd edition, edited and amended. - Moscow: Forum: Scientific and research center INFRA-M, 2014. - 240 p. http://znanium.com/bookread.php_book=447828 2. Foundation of statistical analysis. Practical course for statistical methods and research operations with the use of STATISTICA and EXCEL: Study guide / Vukolov E.A. – 2nd edition, edited and amended. - Moscow: Forum: Scientific and research center INFRA-M, 2013. - 464 p.: http://znanium.com/catalog.php-bookinfo=369689 3. Wavelet-analysis and its application: Study guide / Zakharova T.V., Shestakov O.V.. - Moscow: INFRA-M, 2012. - 158 p.: http://znanium.com/bookread.php-book=466585 Additional literature 1. Borovkov A.A. Mathematical statistics.[3rd edition, amended]. Moscow: Fizmatlit, 2007.703 p. 2. Levin B.R. Theoretical basics of statistical radiotechnics. 3rd edition, edited and amended Moscow: Radio and communication, 1989.-653 p. 3. Tikhonov V.I. Statistical radiotechnics. Moscow: Radio and communication, 1982.-624p. Internet resources: MachineLearning.ru - http://www.machinelearning.ru/ MATLAB.exponenta - http://matlab.exponenta.ru/ Journal of DSP- http://www.dspa.ru/ All-Russian mathematical web portal - http://www.mathnet.ru/ School of data analysis - http://shad.yandex.ru/

Course name Physics of Nonlinear phenomena				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
1	15 weeks.	Compulsory	2	In-class- 26 Self-study - 46

Enrollment requirements	Exam type (oral, written, course work, etc.)	Educational methods (lectures, seminars, etc.)	Course coordinator
	credit	Lectures, practice	M.N. Ovchinnikov

Learning outcomes
1. must know: Peculiarities of nonlinear waves' advance. 2. must be able to: Use criteria of dynamic chaos. 3. must have: Methods of fractional differentiation and integration. 4. must show ability and willingness: Carry out continued and discrete wavelet transformations.

Contents
Topic 1. Local and unequal temperature models of transport processes. Dispertion relation, phase and group wave velocity. *Lecture(4 hour(s)):* Topic 2. Waves in liquid. Gravity waves in liquids. Cappilary-gravity waves. Situation of shallow water, situation of deep water. *Lecture(4 hour(s)):* Topic 3. Stationary solution of nonlinear equation. Burger's equation. KdV equation. Velocity of nonlinear waves. *Lecture(4 hour(s)):* Topic 4. Comples dynamics of nonlinear systems. Lorenz model. Benard convection. Dynamic chaos. Criteria.Model systems. Poincare map. Lyapunov exponent. Control of chaos. *Lecture(6 hour(s)):* Topic 5. Chaos and fractals. Self-similarity. Evolution equation in fractional derivatives. *Lecture(4 hour(s)):* Topic 6. Basic definitions amd methods of wavelet-analysis. Fourier and wavelet-analysis. Criteria. Continued and dicrete wavelet-transformation. Characteristics. Scalogram. *Lecture(4 hour(s)):*

Exemplary literature
Basic literature 1. Waves and structures in nonlinear media without dispersion. Applications to nonlinear acoustics. Gurbatov S.N., Rudenko O.V., Saichev A.I. "Fizmatlit"Publishing house: 978-5-9221-1042-6ISBN: 2011:496 p.// http://e.lanbook.com/books/element.php-pl1_id=2171 2. Theory of linear and nonlinear oscillations. Aldoshin G.T. "Lan'" Publishing house: 978-5-8114-1460-4ISBN: 2013: 2nd edition. Edition: 320p.// http://e.lanbook.com/books/element.php-pl1_id=4640 3. Backbone of nonlinear escillations theory. Skubov D.Ju. "Lan'"Publishing house:978-5-8114-1470-3ISBN: 2013: 1st edition. Edition:320 p.// http://e.lanbook.com/books/element.php-pl1_id=30203 4. CSynergetics in physical processesSelf-organization of physical systems. Pelyukhova E.B., Fradkin E.E. "Lan'" Publishing house: 978-5-8114-1138-2ISBN: 2011: 2nd edition, amended.Edition:448 p.// http://e.lanbook.com/books/element.php-pl1_id=649 Additional literature 1. Shuster G.Detreministic chaos. Moscow, Mir, 1988, 240p. 2. Kravtsov Ju.A. Chance and predictability of dynamistic chaos. Collection of Nonlinear waves, Moscow, Nauka, 1989, p.276-288. 3. Astafieva N.M. Wavelet-analysis: Backbones of theory and examples of its application // Success of physical sciences.- 1996.-Part.166, №11.- p.1145-1170. 4. Sobolex S.L. Local and unequal temperature models oftransport processes. UFN, 1997. №167(10).-p.1095-1106 . 5. Bkhatnagar P. Nonlinear waves in one-dimensional disperse systems. Moscow, Mir, 1983, 136p. 6. Landau L.D., Lifshitz E.M. Hydrodynamics. Moscow: Fizmatlit.-2003.-736p. 7. Mun F., Chaotic oscillations. Moscow, Mir, 1990, 312 p. 8. Dryomin I.M., Ivanov O.V., Nechitaylo V.A. Wavelets and their use // Success of pfysical sciences. - 2001. - pzrt.171. - №5. - p.465-501. 9. Malla S. Wavelets in signals' processing. Moscow: Mir, 2005, 671 p. Internet resources: Loskutov A.Ju. Fascination with chaos. - http://ufn.ru/ufn10/ufn10_12/Russian/r1012c.pdf Linear and nonlinear waves in Линейныеdispersive continuous media.. -

http://e.lanbook.com/books/element.php-pl1_id=2665
Theory and practice of wavelet transformation, internet resources (V. Gribunin) - http://www.autex.spb.ru/wavelet/
Turbulens and self-organization. Problems of modeling space and natural environments. Kolesnichenko A.V., Marov M.Ja. - http://e.lanbook.com/books/element.php-pl1_id=4382

Course name Mechanisms of magnetic relaxation				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
2	18 weeks.	Compulsory	2	In-class- 28 Self-study - 44

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

Learning outcomes

As a result of the discipline acquisition a student:
1. must know:
Main mechanisms and processes of electronic and nuclear spin lattice relaxation.
2. must be able to:
Evaluate velocity of nuclear and electronic relaxation at the expense of different processes of relaxation.
3. must have:
Method of velocity calculation of spin lattice relaxation under different mechanism of relaxation
4. must show ability and willingness:
Advanced self-study of new approaches to learn mechanisms and processes of magnetic relaxation.

Contents

Contents of the discipline
Topic 1. Introduction. Spin lattice relaxation and opportunity to observe the resonance.
Lecture(1 hour(s)):
practice(1 hour(s)):
Topic 2. Relaxation at the expense of interaction of spins with thermal electromagnetic radiaton field.
Lecture(1 hour(s)):
practice(1 hour(s)):
Topic 3. Relaxation at the expense of interaction with phonon field.
Lecture(1 hour(s)):
practice(1 hour(s)):
Topic 4. Phenomenon of phonon bottleneck.
Lecture(1 hour(s)):

practice(1 hour(s)):
Topic 5. Nuclear spin lattice relaxation in insulating diamagnetic crystals, determined by Cap-radient modulation.
Lecture(1 hour(s)):
practice(1 hour(s)):
Topic 6. Nuclear spin lattice relaxation in crystals, determined by isolated impurity paramagnetic centers.
Lecture(2 hour(s)):
practice(2 hour(s)):
Topic 7. Nuclear spin diffusion. Nuclear relaxation through paramagnetic centers with no nuclear spin diffusion. Relaxtion through dipole-dipole reservoir of paramagnetic impurity.
Lecture(1 hour(s)):
practice(1 hour(s)):
Topic 8. Dynamic polarization of diamagnetic atoms' nucleus in solid dielectrics.
Lecture(2 hour(s)):
practice(2 hour(s)):
Topic 9. Nuclear spin lattice relaxation in metals.
Lecture(2 hour(s)):
practice(2 hour(s)):
Topic 10. Nucleus relaxation of diamagnetic atoms in magnetic-ordered insulating crystals.
Lecture(1 hour(s)):
practice(1 hour(s)):
Topic 11. Nuclear relaxation in liquids.
Lecture(1 hour(s)):
practice(1 hour(s)):

Exemplary literature

Basic literature

1. Sergeev N.A. Basic concepts of quantum theory of nuclear magneti resonance: monograph / Sergeev N.A., Ryabushin D.S.. - Moscow: Logos, 2013. - 272 p. - ISBN 978-5-98704-754-5 http://znanium.com/catalog.php-bookinfo=469025
2. Min'ko N.I. Methods of production and characteristics of nanoobjects [e-resource]: Study guide / Min'ko N.I., Strokova V.V., Zhernovsky I.V., Nartsev V.M.. – 2nd edition - Moscow: FLINTA, 2013. - 165 p. - ISBN 978-5-9765-0326-7 http://znanium.com/catalog.php-bookinfo=462886
3. Traven' V.F. Organic chemistry. Part 2 [e-resource]: study guide for HEIs : in 3 parts / Traven' V.F. – 3rd edition (e-resource). - Moscow: BINOM. Laboratoria znanij, 2013. - 517 p.:illustrated. - (Textbook for higher school). - ISBN 978-5-9963-2110-0 (part. II), ISBN 978-5-9963-0357 http://e.lanbook.com/books/element.php-pl1_id=8693

Additional literature

1. Abragam A., Blini B. Electronic paramagnetic resonance of transitional ions. Moscow: Mir, 1973, part.1.
2. Abragam A. Nuclear magnetism. Moscow: ill, 1963.
3. Abragam A. Goldman M. Nuclear magnetism: order and disorder. Moscow: Mir, 1984, part.2.
4. Slikter Ch. Basic concepts of magnetic resonance. Moscow: Mir, 1981.
5. Gurevich A.G. Magnetic resonance in ferrites and antiferromagnets. Moscw: Nauka, 1973.
6. Altshuler S.A., Kozyrev B.M. Electronic paramagnetic resonance of element conncetions of intermediate groups. Moscow: Nauka, 1972.
7. Dzheffris K. Dynamic orientation of nuclei. Moscow: Mir, 1965.
8. Kittel Ch. Introduction in solid state physics. Moscow: Nauka, 1978.

Internet resources:

Wikipedia - http://ru.wikipedia.org

Everything a student needs - http://www.twirpx.com/
Scientific library n.a. N.I. Lobachevsky - http://www.kpfu.ru/main_page-p_sub=5056
E-library system - http://ibooks.ru
E-books - http://eknigi.org/

Course name ***Vacuum Physics***				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
1	15 weeks.	Compulsory	2	In-class- 26 Self-study - 46

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	credit	Lectures, labs	E.M. Alakshin

Learning outcomes

As a result of the discipline acquisition a student:
1. must know:
Modern approached to "conclude" and interprete most important physical ideas (perhaps some ideas of other sciences as well) within the framework of physical and vaccum world model. Physical ground rules of every method of vacuum production
2. must be able to:
Know modern methods of vacuum production and research of condensed matter.
3. must have:
Practical knowledge about limits of practical application of methods and their comparison.
4. must show ability and willingness:
A student has to show ability and willingness to work with literature in English, to use actively internet resources.

Contents

Contents of the discipline
Topic 1. Introduction. Molecular-kinetic theory of gases
Lecture(2 hour(s)):
Topic 2. Interface gas-solid body.
Lecture(2 hour(s)):
Topic 3. Idea of vacuum’s ranges. Gas adsorbtion.
Lecture(2 hour(s)):
Lab (3 hour(s))
Topic 4. Diffusion in solids.
Lecture(2 hour(s)):
Topic 5. Physical processes in vacuum.
Lecture(2 hour(s)):
Topic 6. Diffusion in gases.
Lecture(1 hour(s)):

Topic 7. Mechanical methods of vacuum production.
Lab (4 hour(s)):
Topic 8. Physicochemical method of vacuum production.
Lecture(2 hour(s)):
Topic 9. Physical basis of vaxuum gauging.
Lab (6 hour(s)):

Exemplary literature
Basic literature 1. Vacuum technique: Study guide / Popov A.N. - Moscow: Scientific and research center INFRA-M; Novoe znanie, 2012. - 167 p.: ill.; 60x88 1/16. - (Heigher education: Bachelor's degree). ISBN 978-5-16-006031-6 http://znanium.com/bookread.php-book=317368 2. Physical basis for Electronics: Study guide / Umrikhin V.V.; Unikom Servis. - Moscow: ALFA-M: Scientific and research center INFRA-M, 2012. - 304 p.: ill.; 60x90 1/16. - (Technological service). ISBN 978-5-98281-306-0. http://znanium.com/bookread.php-book=316836 3. Barmasov A.V. Course of general physics for users of nature. Molecular physics and thermodynamics: Study guide / Barmasov A.V., Kholmogorov V.E. / Edited by A.P. Boborovsky. – Saint-Petersburg: BHV - Peterburg, 2009. - 499 p.: ill. - (Course books for HEIs). - ISBN 978-5-94157-731-6. http://znanium.com/bookread.php-book=349974 4. Electronics: Course book / Galperin M.V.. – 2nd edition, edited and amended. - Moscow: ID FORUM: Scientific and research center INFRA-M, 2014. - 352 p.: ill.; 60x90 1/16. - (Professional education). (Binding) ISBN 978-5-8199-0176-2 http://znanium.com/bookread.php?book=420238 Additional literature 1. Dashman S. Scientific basis of vacuum technique. Moscow: "MIR", 716 p. 1964 2. Rosanov L. N. Vacuum technique. Moscow: Higher school, 320 p. 1990. Internet resources: Vacuum and Physics. - http://www.socratus.com/rus/vacuum-rus.htm Information from Wikipedia – The free encyclopedia - http://ru.wikipedia.org/wiki/Вакуум On nature of perfect vacuum - http://kosinov.314159.ru/kosinov7.htm Main physical ideas about vacuum's nature - http://rae.ru/fs/-section=content&op=show_article&article_id=2070 Vacuum's constitution (Lennauchfilm) - http://www.youtube.com/watch-v=PqqgYpUrd7I Vacuum's structure - http://www.youtube.com/watch-v=ntgX_NcxfP8

Course name Special laboratory course for steady-state electronic paramagnetic resonance				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
1	15 weeks.	Compulsory	2	In-class- 26 Self-study - 46

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	Credit	Laboratory course	G.V. Mamin

Learning outcomes
As a result of the discipline acquisition a student: 1. must know: Main methods of measuring of steady-state EPR and ENDR spectra 2. must be able to: Record and decode EPR spectra, decode fine, hyperfine and superhyperfine structure of EPR spectra. 3. must have: Operating skills for EPR spectrometer and methods of EPR spectra measuring. Skills of computation and measuring of main spectroscopic characteristics. 4. must show ability and willingness: Carry out measuring with modern EPR spectrometers, applying received knowledge for getting reliable spectroscopic characteristics.

Contents
Contents of the discipline Topic 1. Research of steady-state EPR spectra of carbonated samples *Lab (14 hour(s)):* Topic 2. Research of fine and superhyperfine structure of EPR spectra of ferric iron ions in crystals LiCaAlF6 and LiSrAlF6 *Lab (14 hour(s)):*

Exemplary literature
Basic literature 1. Zaripov M.M. Foundations of the theory of electronic paramagnetic resonance spectra in crystals: course of lectures / Zaripov M.M. //- Kazan: Kazan State University, 2009.- 212 p. : ill. ; 21 sm. - Bibliography: p. 205-206 (24 names.)? ISBN 978-5-98180-707-7, 225 2. Tkachenko F.A. Electronics: Textbook / F.A. Tkachenko . - Moscow: INFRA-M; Novoe znanie, 2011. - 682 p: ill.; 60x90 1/16. - (Higher education). (Binding) ISBN 978-5-16-004658-7 http://znanium.com/bookread.php?book=209952 3. pershin V.T. Forming anf generating of signals in digital radio: Study guide / V.T. Pershin. - Moscow: Scientific and research center INFRA-M; Novoe znanie, 2013. - 614 p.: ill.; 60x90 1/16. - (Higher education: Bachelor's degree). (Binding) ISBN 978-5-16-006703-2, 600 copies. http://www.znanium.com/bookread.php-book=405030 Additional literature 1.Study guide "Adjustment of x-range spectrometer of Bruker company, Elexsys line and measuring of EPR spectra in steady-state condition" /Kutiin Ju.S., Mamin G.V., Orlinsky S.B., Silkin N.I. // 2014. Educational e-resource http://gmamin.kpfu.ru/MRpract/X_band_CW. pdf 2. Study guide "Use of software module EasySpin for analyzing spectra of magnetic resonance " / Mamin G.V., Orlinsky S.B., Silkin N.I., Subacheva I.N., Jusupov R.V. // 2014. Educational e-resource http://gmamin.kpfu.ru/MRpract/easyspin.pdf 3. Electronic paramagnetic resonance of transition groups ions, Part. II / Abragam A., Blini B., Part II, Mir, Moscow 1973, 349p 4. Altshuler S.A., Kozyrev B.M. Electronic paramagnetic resonance, Moscow: Nauka,1972. Internet resources: Study guides - http://www.gmamin.kpfu.ru Search system Scopus - http://www.scopus.com/home.url Software Balls & Sticks - http://www.toycrate.org/bs/index.html

Software Easyspin - http://www.easyspin.org/
Software Matlab - www.mathworks.com/
Elsevier Editor's website - http://elsevierscience.ru/
Bruker company website - www.bruker-biospin.de
Common use center of the University - http://www.kpfu.ru/main_page-p_sub=11446

Course name Modern methods of micro and spectroscopy of solid bodies				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
1	15 weeks.	Compulsory	4	In-class- 26 Self-study - 82

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	Exam	Lectures, practice	M.S. Tagirov

Learning outcomes

As a result of the discipline acquisition a student:
1. must know:
Physical principles, underlying every method of solid bodies research
2. must be able to:
Know modern research methods of condensted matter
3. must have:
Knowledge about limits of practical appliance of methods and their comparison
4. must show ability and willingness:
Work freely with professional literature, and in Internet in English as well

Contents

Topic 1. Introduction.
Lecture(1 hour(s)):
practice(1 hour(s)):
Topic 2. Field-ion microscopy.
Lecture(1 hour(s)):
practice(1 hour(s)):
Topic 3. RTransmission microscopy.
Lecture(1 hour(s)):
practice(1 hour(s)):
Topic 4. Scanning electronic microscopy.
Lecture(1 hour(s)):
practice(1 hour(s)):
Topic 5. Scanning electronic microscopy.
Lecture(1 hour(s)):
practice(1 hour(s)):

Topic 6. Scanning force microscopy.
Lecture(1 hour(s)):
practice(1 hour(s)):
Topic 7. Magnetic force microscopy.
Lecture(1 hour(s)):
practice(1 hour(s)):
Topic 8. NMR-based microscopy. Quantum magnetometer-based microscopy.
Lecture(1 hour(s)):
practice(1 hour(s)):
Discussion of information learned in the course of lectures. Addition of new information from internet resources.
Lecture(1 hour(s)):
practice(1 hour(s)):
Topic 10. Electronic Auger-spectroscopy. Ultraviolet photoelectronic spectroscopy.
Lecture(1 hour(s)):
practice(1 hour(s)):
Topic 11. Spectroscopy of pattern electronic losts.
Lecture(1 hour(s)):
practice(1 hour(s)):
Topic 12. Thermal desorption. Electron-stimulated desorption.
lecture (1 hour):
practical lesson (1 hour):
Topic 13. The fine structure of X-ray absorption. Neutron spectroscopy and neutron diffraction.
lecture (1 hour):
practical lesson (1 hour):

Examplary literature

Basic literature:
1. Barybin, A.A. Physical chemistry of nanoparticles, nanomaterials and nanostructures [Electronic resource]: Study guide / Barybin,A.A.; Bakhtina,V.A.; Tomilin,V.I.; Tomilina,N.P. - Krasnoyarsk: Siberian Federal University, 2011. – p.236 - ISBN 978-5-7638-2396-7. http://znanium.com/bookread.php-book=441543
2. Nanomaterials, nanostructures, nanotechnology / Gusev,A.I. Edition 2, revised. Moscow: FIZMATLIT, 2009, p.416 : illustration. ; 22 cm. - Bibliography at the end of Ch. – Author index: pp.406-407, - Subject index: pp.408-414 .- ISBN 978-5-9221-0582-8 ((in translation))
3. Kapitonov, A.M. Physical and mechanical properties of composite materials. Elastic properties [Electronic resource]: monography / Kapitonov, A.M, Redkin, V.E. – Krasnoyarsk: Siberian Federal University, 2013, p.532 - ISBN 978-5-7638-2750-7.
http://znanium.com/bookread.php-book=492077
Additional literature:
1. Kittel C. Introduction to the solid-state physics. / Kittel C. // M.: Nauka, 1978.
2. Ziman J.Z.M. The principles of the theory of solids. / Ziman J.Z.M. // M.: Nauka, 1974.
3. Kittel C. Quantum theory of solids. / Kittel C. // M.: Nauka, 1967.
4. Ziman J.Z.M. Models of disorder. / Ziman J.Z.M. //M.: Mir, 1982.
Internet resources:
AFM - http://ru.wikipedia.org/wiki/Сканирующий_атомно-силовой_микроскоп
http://dic.academic.ru/dic.nsf/enc_physics/4688/Сканирующий
http://www.mnhs.ru/tools/solver.html
AUGER - http://irmt.ru/index.php/experbase/auger
RFES - http://irmt.ru/index.php/experbase/rfes
SAM - http://interbalt.ru/Downloads/SAM.pdf
http://download.springer.com/static/pdf/992/art%253A10.1134%252FS0020441209050145.pdf?

auth66=1360393211_STM - http://ru.wikipedia.org/wiki/Сканирующий_туннельный_микроскоп http://www.mikroskopia.ru/info/26.html http://www.femto.com.ua/articles/part_2/3680.html http://vestnik.osu.ru/2007_12/28.pdf
TEM - http://irmt.ru/index.php/experbase/tem

Course name The spectra of electron paramagnetic resonance				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
1	15 weeks	Compulsory	4	In class - 39 Self-study - 69

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	Examination	Lectures, practical lessons	Orlinskiy S.B.

Learning outcomes

As a result of the discipline acquisition the student:
1. must know:
- modern theoretical description of the exchange ligand interactions;
- theoretical foundations of modern experimental research methods in the field of electron paramagnetic resonance;
- main classical and modern experimental results on the use of electron spin resonance.
2. must be able:
to apply modern methods of the theory for the calculation of the hyperfine structure of the electron paramagnetic resonance spectra.
3. must posess:
the skills analysis of complex electron paramagnetic resonance spectra.
4. must demonstrate the ability and readiness:
to understand electron paramagnetic resonance as one of the methods of quantum radiophysics.

Contents

Contents of the discipline
Topic 1. The potential of the crystal field in low-symmetrical crystals (monoclinic symmetry)
lecture (2 hours):
practical lesson (1 hour):
Topic 2. Cleavage of D and F therms taking into account the monoclinic symmetry. The wave functions.
lecture (2 hours):
practical lesson (1 hour):
Topic 3. Derivation of the spin Hamiltonian in the case of singlet orbital state with the monoclinic symmetry.
lecture (2 hours):

practical lesson (1 hour):
Topic 4. The parameters of the spin Hamiltonian in the monoclinic symmetry.
lecture (2 hours):
practical lesson (1 hour):
Topic 5. The ability to study the strong exchange interaction by ESR.
lecture (2 hours):
practical lesson (1 hour):
Topic 6. The energy levels of the exchange-coupled pairs (isotropic case). The EPR spectrum (S =S=1/2).
lecture (2 hours):
practical lesson (1 hour):
Topic 7. The energy levels of the exchange-coupled pairs (anisotropic case). The EPR spectrum S =S =1/2
lecture (2 hours):
practical lesson (1 hour):
Topic 8. The hyperfine structure of the EPR spectrum of exchange-coupled pairs: the Zeeman energy is bigger in order and less than the value of the exchange integral.
lecture (2 hours):
practical lesson (1 hour):
Topic 9. The fine structure of the EPR spectrum of exchange-coupled triples.
lecture (3 hours):
practical lesson (2 hours):
Topic 10. The impact of the antisymmetric exchange interaction on the EPR spectrum.
lecture (2 hours):
The effect of the antisymmetric exchange interaction on the EPR spectrum is under discussion.
practical lesson (1 hour):
Topic 11. Forbidden lines of the EPR spectrum in the ligand interaction.
lecture (3 hours):
practical lesson (1 hour):
Topic 12. The calculation of the spectrum of electron-nuclear double resonance with the fine structure of the spectrum ENDOR.
lecture (2 hours):
practical lesson (1 hour):

Exemplary literature

Basic literature:
1. Zaripov, M.M. Fundamentals of the theory of electron paramagnetic resonance in crystals: a course of lectures. / M.M.Zaripov // - Kazan: Kazan University, 2009, p.212: illustration; 21 cm. - Bibliography: pp.205-206 (24 items). - ISBN 978-5-98180-707-7, 225
2. Physical and chemical bases of technology of building materials: Study guide / Kovalev, Ya.N. - M.: Research center “Infra-M” ; New edition, 2012, p.285: illustration.; 60x90 1/16. - (Higher Education). (Hardcover) ISBN 978-5-16-005580-0, http://znanium.com/bookread.php?book=278683
3. Bezborodov, Yu.N. Methods of monitoring and diagnosis of operational properties of lubricants in the parameters of thermal oxidative stability and thermal stability [Electronic resource]: monography / Bezborodov, Yu.N., Kovalskiy, B.I., Malysheva, N.N., Sokolnikov, A.N., Maltseva, E.G. - Krasnoyarsk: Siberian Federal University, 2011, p.366 – ISBN 978-5-7638-2225-0. http://znanium.com/bookread.php?book=442965
Additional literature:
1. Study guide “Using the software module EasySpin in the analysis of magnetic resonance spectra" / Mamin, G.V., Orlinskiy, S.B., Silkin, N.I., Subacheva, I.N., Yusupov, R.V. // 2014 electronic educational resource: http://gmamin.kpfu.ru/MRpract/easyspin.pdf

2. Study guide for students of physical, biological and chemical faculties "Spin traps in biology and medicine. Registration of nitric oxide and copper compounds" / Mamin, G.V., Orlinskiy, S.B., Silkin, N.I., Chelyshev, Yu.A., Shtyrlin, V.G., Yusupov, R.V. // Publishing office of Kazan University, Kazan, 2010
old.kpfu.ru/f6/bin_files/spinlabels!38.pdf
3. Electron paramagnetic resonance of ion transition groups, Vol. II / Abraham, A., Blini, B., Vol. II, Mir, Moscow, 1973, p.349.
4. Altshuler, S.A, Kozyrev, B.M. Electron paramagnetic resonance, M .: Nauka, 1972.
5. Search system Scopus that enables students to search for articles about the methods of EPR spectroscopy used nowadays in the course. www.scopus.com
Internet resources:
Search system Scopus - http://www.scopus.com/home.url
Program Balls & Sticks - http://www.toycrate.org/bs/index.html
Program Easyspin - http://www.easyspin.org/
Program Matlab - www.mathworks.com/
Publisher site Elsevier - http://elsevierscience.ru/
Site of the company Bruker - http://www.bruker-biospin.de
Common use center KPFU - http://www.kpfu.ru/main_page-p_sub=11446

Course name Special practicum on the pulse electron paramagnetic resonance				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
2	18 weeks	Compulsory	3	In-class - 32 Self-study - 76

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	credit	Laboratory lessons	Mamin G.V.

Learning outcomes

As a result of the discipline acquisition the student:
1. must know:
basic methods of measurement of ESR spectra, ENDOR, EPR relaxation
2. must be able:
- to record and decode spectra of pulsed EPR, decode fine, superfine and super-hyperfine structure of the EPR spectra.
- to record and decode the ENDOR spectra.
- to record and decode spectra HYSCORE.
- to measure the longitudinal and transverse relaxation.
3. must possess:
- the skills of working with the EPR spectrometer and by measurement methods of EPR spectra and relaxation curves.
- the skills of calculation and measurement of the main spectroscopic and relaxation parameters.
4. must demonstrate the ability and readiness:

to carry out measurements on modern EPR spectrometers using this knowledge in order to get reliable spectroscopic and relaxation characteristics.

Contents
Topic 1. Research of pulsed EPR spectra, time relaxation, spectra ENDOR, HYSCORE spectra of carbonized samples. *Laboratory lesson (16 hours)* Topic 2. Research of photoexcited pulsed EPR spectra, time relaxation, optical temporal characteristics of advanced materials for quantum computers. *Laboratory lesson (16 hours)*

Exemplary literature
Basic literature: 1. Zaripov, M.M. Fundamentals of the theory of electron paramagnetic resonance in crystals: a course of lectures. / M.M.Zaripov // - Kazan: Kazan University, 2009 2. Tkachenko, F.A. Electronic equipment and devices: Textbook / Tkachenko, F.A. - M .: INFRA-M; Novoe znanie, 2011. – p. 682 : illustrations; 60x90 1/16. - (Higher Education). (Hardcover) ISBN 978-5-16-004658-7 http://znanium.com/bookread.php-book=209952 3. Pershin, V.T. Formation and generation of signals in digital radio: Study guide / Pershin, V.T. - M.: Research center “Infra-M”; Novoe znanie, 2013. – p.614 : illustrations; 60x90 1/16. - (Higher Education: Bachelor’s program). (Hardcover) ISBN 978-5-16-006703-2, 600 copies. http://www.znanium.com/bookread.php?book=405030 Additional literature: 1. Study guide "EPR spectrometer Elexsys580. Part 2: Pulse mode, setup and operation" / Kutyin, Yu.S., Mamin, G.V., Orlinskiy, S.B., Silkin, N.I. // 2014. Electronic educational resource http://gmamin.kpfu.ru/MRpract/X_band_pulse.pdf 2. Study guide "EPR spectrometer Elexsys E580. Part 3: The electron-nuclear double resonance (ENDOR)" / Duglav, A.V., Kutyin, Yu.S., Mamin, G.V., Orlinskiy, S.B., Silkin, N.I., Gafurov, M.R., // 2014. Electronic educational resource http://gmamin.kpfu.ru/MRpract/elexsys580-DEER.pdf 3. Electron paramagnetic resonance of ion transition groups, Vol. II / Abraham, A., Blini, B., Vol. II, Mir, Moscow, 1973, p.349. 4. Altshuler, S.A, Kozyrev, B.M. Electron paramagnetic resonance, M .: Nauka, 1972. Internet resources: Study guides - http://www.gmamin.kpfu.ru Search system Scopus - http://www.scopus.com/home.url Program Balls & Sticks - http://www.toycrate.org/bs/index.html Program Easyspin - http://www.easyspin.org/ Program Matlab - www.mathworks.com/ Publisher site Elsevier - http://elsevierscience.ru/ Site of the company Bruker - http://www.bruker-biospin.de Common use center KPFU - http://www.kpfu.ru/main_page-p_sub=11446

Course name The theory of impurity centers in crystals				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
2	18 weeks	Compulsory	2	In class - 28 Self-study - 44

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

Learning outcomes
As a result of the discipline acquisition the student: 1. must know: - modern theoretical level describing the energy scheme level of the impurity centers with unfilled 3d- and 4f- shells; - theoretical foundations of modern experimental methods of fine and hyperfine structure of magnetic centers; - modern experimental results concerning the magnetic properties of solids. 2. must be able: to apply modern methods of analysis of the magnetic properties, including the pecularities of electron-nuclear and electron-phonon interactions. 3. must possess: - the skills of scientific analysis of the problems of the system (both natural and professional) of various levels of complexity; - the skills of working with basic theoretical methods of description, such as the method of effective spin operators and the method of molecular orbitals. 4. must demonstrate the ability and readiness: Must know: - modern theoretical level describing the energy scheme level of the impurity centers with unfilled 3d- and 4f- shells; - theoretical foundations of modern experimental methods of fine and hyperfine structure of magnetic centers; - modern experimental results concerning the magnetic properties of solids. Must be able: to apply modern methods of analysis of the magnetic properties, including the pecularities of electron-nuclear and electron-phonon interactions. Possess: - the skills of scientific analysis of the problems of the system (both natural and professional) of various levels of complexity; - the skills of working with basic theoretical methods of description, such as the method of effective spin operators and the method of molecular orbitals.

Contents
Topic 1. Introduction. Interaction of van der Waals. *lecture (2 hours):* Topic 2. The exchange interaction. The orthogonalization of the wave functions of Bogolyubov-Levdin. An efficient operator. *lecture (4 hours):* *practical lesson (4 hours):* Topic 3. Covalent binding. The method of molecular orbitals. *lecture (2 hours):*

practical lesson (4 hours):
Topic 4. Ligand hyperfine structure.
lecture (2 hours):
practical lesson (2 hours):
Topic 5. Reduction of Slater's settings in impurity centers.
lecture (2 hours):
practical lesson (2 hours):
Topic 6. Jahn-Teller effect.
lecture (2 hours):
practical lesson (2 hours):

Exemplary literature
Basic literature: 1. Nanomaterials, nanostructures, nanotechnology / Gusev,A.I. Edition 2, revised. Moscow: FIZMATLIT, 2009, p.416 : illustration. ; 22 cm. - Bibliography at the end of Ch. – Author index: pp.406-407, - Subject index: pp.408-414 .- ISBN 978-5-9221-0582-8 ((in translation)). 2. Microscopic models in condensed matter. Eremin, M.V., Study guide KGU, 2011, p.112. http://kpfu.ru/docs/F1043614157/Eremin_Posobie_2011.doc 3. Tkachenko, F.A. Electronic equipment and devices: Textbook / Tkachenko, F.A. - M .: INFRA-M; Novoe znanie, 2011. – p. 682 : illustrations; 60x90 1/16. - (Higher Education). (Hardcover) ISBN 978-5-16-004658-7 http://znanium.com/bookread.php-book=209952 Additional literature: 1. Electron paramagnetic resonance of ion transition groups, Vol. II / Abraham, A., Blini, B., Vol. II, Mir, Moscow, 1973. 2. Malkin, B.Z. The quantum theory of paramagnetism. Lecture notes. KFU publishing office, 2006, p.83 To download: http://kpfu.ru/portal/docs/F800871619/quant_theory_param.pdf Internet resources: Archive of publications on physics - http://xxx.lanl.gov/find/cond-mat The data on the crystal structure in the database - http://www.crystallography.net Newsletter "PERST". Promising technologies. - http://perst.issp.ras.ru Study guides - http://www.kpfu.ru/main_page-p_sub=8205 A program for calculating 3-j , 6-j и 9-j symbols - http://plasma-gate.weizmann.ac.il/369j.html

Course name Computer technologies				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
1,2	15,18 weeks.	Compulsory		In-class - 41 Self-study - 103

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	Examination credit	Lectures, practical lessons	Sherstyukov O.N.

Learning outcomes
1. must know: To possess the theoretical knowledge of computer architecture and functioning of the main components of its elements, the organization of computer networks. 2. must be able: To acquire the problem-solving skills of a wide range of tasks, using the computer and other hardware and software. 3. must possess: The problem-solving skills concerning the computer. 4. must demonstrate the ability and readiness: To solve the problems with the help of the computer.

Contents
Topic 1. Intriduction. Information support research. *lecture (1 hour):* Topic 2. Equipment of information and computing systems. Automation of experimental research in physics and radiophysics. *lecture (2 hours):* Topic 3. General principles of networks. Data channels and their characteristics. *lecture (2 hours):* Topic 4. Local networks. Methods of access to information in the network. Construction of LAN technology based on Ethernet. *lecture (2 hours):* Topic 5. The Internet. Application service protocols. Hypertext Internet technology. *lecture (2 hours):* Topic 6. Databases. Basic definitions. Logical organization databases. *lecture (2 hours):* Topic 7. Specialized and general purpose software products in research. *lecture (2 hours):* Topic 8. Construction of LAN technology based on Ethernet. Network applications. The use of network resources. *practical lesson (7 hours):* Topic 9. Applied service protocols. Hypertext Internet technology. Internet telephony. *practical lesson (7 hours):* Topic 10. Development of Web-site. Development of interactive elements. Creation of the electronic textbook using HTML language. *practical lesson (7 hours):* Topic 11. MATLAB and MATCAD packages, a brief description and classification. Preparation and presentation of the report. *practical lesson (7 hours):*

Exemplary literature
Basic literature: 1. Olifer, V.G. Fundamentals of computer networks: [Study guide: basics of networking, technology of local and global networks, overview of popular network services and services] / Olifer, V., Olifer, N.- St. Petersburg [etc.]: Piter, 2014 - p.400 (97) 2. Zhuk, A.P. Data protection: Study guide / Zhuk, A.P., Zhuk, E.P., Lepeshkin, O.M., Timoshkin, A.I. - 2-nd edition - M.: Information center RIOR: Research center «Infra-M», 2015. – p.392 : http://znanium.com/bookread.php-book=474838 Electronic resource.

3. Informatics: Textbook / Gurikov, S.R. - M .: Forum: Research center «Infra-M», 2014. – p.464: http://znanium.com/bookread.php-book=422159 Electronic resource.
4. Information technologies and systems: Textbook / Fedotova, E.L. - M .: ID FORUM: Research center «Infra-M», 2014. – p.352 : http://znanium.com/catalog.php-bookinfo=422159 Electronic resource.
Additional literature:
1. Kostylev, K.K. New information technologies. K. Kaz. Univ. 1998. 88 (30)
2. Stenin, Y.M. Principles of organization and computer devices. K. Kaz. Univ. 2001. pp.48 (50).
3 Broydo, V.L. Computer systems, networks and telecommunications. St. Petersburg: Piter, 2002. p.683 (4)
4. Sherstyukov, O.N, Maksyutin, S.V. Fundamentals of information systems. Study guide: Kazan, 2008. p.74 http://radiosys.ksu.ru/ICS_start.html Electronic resource.
1. Romanets, Yu.V., Timofeev, P.A., Shangin, V.F. Protection of information in computer systems and networks. M. Radio i svyaz. 2001 p.367 (2)
Inernet resources:
Documentation on PHP - http://www.php.ru
Morris B. HTML in use. - http://web-mastery.info/books/book-30.html
Site of radio laboratory (Radio Physics Department) - http://radiosys.ksu.ru
Electronic library system ZNANIUM.COM - http://znanium.com/
Electronic library system of publishing office «Lan» - http://e.lanbook.com/

Course name *Nanophysics*				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
2	18 weeks	Elective	3	In-class - 42, Self-study - 66

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

Learning outcomes

As a result of the discipline acquisition the student:
1. must know:
the pecularities of 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 during your work the reference books and textbooks in the field of physics of nanostructures and nanotechnology, to find other relevant information sources and work with them.
3. must possess:
the theoretical knowledge of the fundamental concepts of quantum theory and statistical physics nanoscopic and mesoscopic systems.
4. must demonstrate the ability and readiness:

for further study.

Contents

Topic 1. Introduction.
lecture (2 hours):
Topic 2. Fundamentals of the theory of quantum phenomena.
lecture (4 hours):
Topic 3. Derivatization of nanostructures.
lecture (4 hours):
practical lesson (2 hours):
Topic 4. Derivatization of nanostructures.
lecture (2 hours):
practical lesson (2 hours):
Topic 5. Methods of research of nanostructures.
lecture (4 hours):
practical lesson (2 hours):
Topic 6. Transport phenomena in nanostructures..
lecture (2 hours):
Topic 7. Superconductivity in mesoscopic systems.
lecture (2 hours):
Topic 8. Magnetic properties of nanostructures.
lecture (4 hours):
practical lesson (2 hours):
Topic 9. Allotropes of carbon.
lecture (2 hours):
practical lesson (2 hours):
Topic 10. Photonic crystals.
lecture (2 hours):
practical lesson (4 hours):

Exemplary literature

Basic literature:
1. Andrievsky, R.A. Fundamentals of nanostructured materials science. Opportunities and challenges. - M: "Binom. Laboratory of knowledge", 2012 - p.186 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 / edited by Sigova A.S. - M. "Binom. Laboratory of knowledge", 2013. – p.184 http://e.lanbook.com/books/element.php?pl1_id=42636.
3. Scanning electron microscopy for nanotechnology: methods and application: translated from English. / edited by Zhu, U., Whang, Zh.L. - M .: "Binom. Laboratory of knowledge", 2013. – p.582 http://e.lanbook.com/books/element.php?pl1_id=8689.
7.2. Aditional latediterature:
1. Gusev, A.I. Nanomaterials, nanostructures, nanotechnology. / Gusev, A.I. 2-nd edition, corrected. - M.: Fizmatlit, 2009. – p.416. http://e.lanbook.com/books/element.php?pl1_id=2173.
2. Quantum challenge: modern research foundations of quantum mechanics: [Study guide] / Greenstein, J., Zajonc, A.G.; transl 2-nd edition edited and added. Aristova, V.V., Nikulova, A.V.; added to the 2-nd edition on russian language. Nikulova, A.V. – 2-nd edition, [added].. - Dolgoprudniy: Intellekt, 2012. – p.431 : illustration.
7.3. Internet-resources:
Nanotechnology journal - http://www.nanoru.ru/

Nanometr - http://www.nanometer.ru/
Nanotechnology now - http://www.nanotech-now.com/
Nanotechnology news - http://www.sciencedaily.com/news/matter_energy/nanotechnology/
Rosnano - http://www.rusnano.com/

Course name Quantum theory of magnetism				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
2	18 weeks	elective	3	In-class – 42 Self-study - 66

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

Learning outcomes

As a result of the discipline acquisition the student:
1. must know:
- modern theoretical level of 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 modern 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 possess:
- the skills of the system scientific analysis of the problems (both natural and professional) of various levels of complexity;
- the skills of working with the basic theoretical methods in the field of magnetism of condensed matter physics and the modern scientific literature.
4. must demonstrate ability and readiness:
to use gained knowledge to describe real physical systems.

Contents

Contents of the discipline
Topic 1. The magnetic moments.
lecture (4 hours):
practical lesson (2 hours):
Topic 2. The magnetic properties of the system of non-interacting localized moments.
lecture (4 hours):
practical lesson (2 hours):
Topic 3. The magnetic properties of systems of weakly interacting localized moments.

lecture (4 hours):
practical lesson (2 hours):
Topic 4. The magnetism of systems of strongly interacting moments.
lecture (8 hours):
practical lesson (4 hours):
Topic 5. The magnetic properties of the systems with magnetic impurities.
lecture (4 hours):
practical lesson (2 hours):
Topic 6. Spin glasses.
lecture (4 hours):
practical lesson (2 hours):

Exemplary literature
Basic literature: 11. Abrikosov, A.A. Fundamentals of the theory of metals M. FIZMATLIT. - 2010. – p.600. http://e.lanbook.com/view/book/2093/ 2. Borisenok, S.V., Kondratiyev, A.S. Quantum statistical mechanics. M .: FIZMATLIT, 2011. – p.136 http://e.lanbook.com/view/book/2672/ 3. Aminov, L.K. The dynamics and kinetics of electron and spin excitations in paramagnetic crystals / Aminov, L.K., Malkin, B.Z. - Kazan:Publishing office of KFU, 2008.- p.217. http://kpfu.ru/docs/F1917339624/DynamicsSpinParamagnets_Aminov_Malkin.pdf Additional literature: Lectures on magnetism, Borovik, E.S., Eremenko, V.V., Milner, A.S., 2005. Electricity and Magnetism, Matveev, A.N., 2010. Internet resources: Joint Quantum Institute - http://jqi.umd.edu/ Institute for Theoretical Physics Landau, L.D.. Sector of Quantum mesoscopics - http://qmeso.itp.ac.ru/ Bonded magnets and magnet systems - http://www.valtar.ru/index.html Science and life - http://www.nkj.ru/ Physical encyclopedia - http://www.femto.com.ua/index1.html

Course name Cryogenics				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
3	16 weeks	Elective	2	In-class - 28 Self-study 44

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	credit	Lectures	Tagirov M.S.

Learning outcomes
As a result of the discipline acquisition the student: 1. must know: basic laws of physics, which is based on the technique of obtaining and measuring the low and very low temperatures 2. must be able: to explain the basics of quantum-mechanical theory of charge, mass and spin (magnetic) superfluidity. 3. must possess: the knowledge of specific physical phenomena that occur at low and ultralow temperatures. 4. must demonstrate the ability and readiness: to work independently with the special literature and with Internet on english language.

Contents
Topic 1. Introduction to the physics of low temperatures. *lecture (2 hours):* Topic 2. Transport phenomena at low temperatures. *lecture (2 hours):* Topic 3. Superconductivity (low and high temperature). *lecture (2 hours):* Topic 4. Thermal conductivity of solids at low and ultralow temperatures. *lecture (2 hours):* Topic 5. Electrons and liquid helium. *lecture (2 hours):* Topic 6. Superfluidity. The main properties of liquid 4He and 3He. *lecture (2 hours):* Topic 7. The properties of quantum crystals. The specific heat, thermal conductivity. *lecture (2 hours):* Topic 8. Hyperpolarised helium-3. Methods of preparation and basic properties. *lecture (2 hours):* Topic 9. The spin (magnetic) superfluidity. *lecture (2 hours):* Topic 10. Bose-Einstein condensation. *lecture (2 hours):* Topic 11. he Josephson effect. *lecture (2 hours):* Topic 12. Laser cooling. *lecture (2 hours):* Topic 13. Neutron stars. *lecture (4 hours):*

Exemplary literature
Basic literature: 1. Demikhov, K.E., Panfilov, Y.V., Nikulin, N.K., Avtonomova, I.V. Vacuum Technology: Mechanical engineering "Publishing office: 2009 p.590 978-5-94275-436-5ISBN: http://e.lanbook.com/view/book/723/ 2. Superconductivity / Ginsburg, V.L., Andryushin, E.A. - 2-nd edition, revised and added - M .: Alpha-M, 2006. – p.110 : illustrations; 60x90 1/16. - (Library of SDI "The ideas and technologies of the future"). (Hardcover) ISBN 5-98281-088-6, http://znanium.com/bookread.php-

book=114620
3. Art of Cryogenics: low-temperature technique in a physical experiment, industrial and aerospace applications: [Educational Reference Guide] / Ventura, G., Rizegari, L.; translated from English. Edited by Mezhova-Deglina, L.P. - Dolgoprudniy: Intellekt, 2011 - p.332: illustrations; 24.
Additional literature:
1. Lounasmaa, O.V. Principles and methods of the production of temperatures below 1K. Moscow: Mir, 1977.
2. White, G.K. Experimental technique in low-temperature physics. Moscow: Publishing office of physics and mathematics literature, 1961.
3. Rozanov, L.N. Vacuum technology: textbook for high schools, speciality "Electronic Engineering" / Rozanov, L.N. - 3rd edition, revised and added. – M.: Higher School, 2007.- p.391.
4. Sheshin, E.P. Vacuum technology: study guide. / Sheshin, E.P. - Dolgoprudniy: Intellekt, 2009. – p.501.
Internet resources:
BEC - http://en.wikipedia.org/wiki/Bose-Einstein_condensate
HTSC - http://en.wikipedia.org/wiki/High-temperature_superconductivity
Superconductivity - - http://en.wikipedia.org/wiki/High-temperature_superconductivity
Superfluidity - http://en.wikipedia.org/wiki/Superfluidity
Superglass - http://www.phys.ens.fr/~zamponi/archivio/talks/2009-02-24-firenze.pdf
Supersolid - http://en.wikipedia.org/wiki/Supersolid
Ginsburg, V.L. - http://ufn.ru/dates/nobel2003/Gin_nob_r.pdf
Institute of Solid State Physics, RAS - http://www.dynastyfdn.com/events/165

Course name Radiophysical research methods of substances and materials				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
2	14 weeks	elective	5	In-class- 56 Self-study - 106

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

Learning outcomes
As a result of the discipline acquisition the student: 1. must know: the limits of the practical application of methods and their comparison. 2. must be able: to navigate the modern methods of research of condensed matter. 3. must possess: the limits of the practical application of methods and their comparison. 4. must demonstrate the ability and readiness: to work independently with the special literature and with Internet on english language

Contents
Contents of the discipline Topic 1. Introduction *lecture (2 hours):* Topic 2. Magnetometry of human brain *lecture (2 hours):* *practical lesson (2 hours):* Topic 3. Magnetic cardiology *lecture (2 hours):* *practical lesson (2 hours):* Topic 4. Superstrong magnetic fields *lecture (4 hours):* *practical lesson (4 hours):* Topic 5. NMR in high magnetic fields *lecture (2 hours):* *practical lesson (2 hours):* Topic 6. Stationary EPR in the strong magnetic fields *lecture (2 hours):* *practical lesson (4 hours):* Topic 7. Electron spin echo in strong magnetic fields *lecture (2 hours):* *practical lesson (2 hours):* Topic 8. EPR autotomography *lecture (2 hours):* *practical lesson (2 hours):* Topic 9. NMR autotomography *lecture (4 hours):* *practical lesson (4 hours):* Topic 10. Nuclear magnetic logging *lecture (4 hours):* *practical lesson (4 hours):* Topic 11. Dielectric spectroscopy *lecture (2 hours):* *practical lesson (2 hours):*

Exemplary literature
Basic literature: 1. Kapustin, V.I. Materials and electronics technology: Study guide / Kapustin, V.I., Sigov, A.S. - M .: Research center «Infra-M», 2014. – p.427.: 60x90 1/16. - (Higher Education: Bachelor's program). (Hardcover) ISBN 978-5-16-008966-9, 200 copies. http://www.znanium.com/bookread.php-book=416461 2. Schuka, A.A. Nanoelectronics [electronic resource]: Study guide / Schuka, A.A; edited by Sigov, A.S. – Electronic edition - M.: BINOM. 2012. – p.342 : Http://znanium.com/bookread.php-book=366748 3. Ignatov, A.N. Classical electronics and nanoelectronics [electronic resource]: Study guide / Ignatov, A.N., Fadeeva, N.E., Savinykh, V.L., Vayspapir, V.Ya., Vorobieva, S.V. - 2nd edition,. M. Flint, 2012. – p.728 http://znanium.com/bookread.php-book=455216 Additional literature: 1. Kittel C. Quantum theory of solids. / Kittel C. // M.: Nauka, 1967. 2. Nanocrystalline materials / Gusev, A.I., Rempel, A.A.- Moscow: FIZMATLIT. 2001 .- p.224.

Additional literature:
Internet resources:
Dielectric spectroscopy - http://www.dissercat.com/content/temperaturnye-issledovaniya-relaksatsionnykh-protsessov-v-geterogennykh-
Импедансная спектроскопия - http://www.dissercat.com/content/issledovanie-plazmy-v-svch-reaktorakh-i-kharakteristik-poluchaemykh-v-nikh-
Magnetometry of human brain - http://www.integro.ru/system/new_science/field_obj/magnit.html
EPR in strong fields - http://www.dissercat.com/content/epr-i-opticheskie-issledovaniya-defektov-v-shirokozonnykh-materialakh-i-
NMR autotomography - http://www.dissercat.com/content/razvitie-metodov-magnitno-rezonansnoi-tomografii-v-issledovanii-samodiffuziii-

Course name Quantum computing and communication of environments				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
3	16 weeks	Elective	2	In-class - 28, Self-study - 44

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

Learning outcomes

As a result of the discipline acquisition the student:
1. must know:
- the foundations of quantum information theory and quantum algorithms.
2. must be able:
- to use quantum elementary operations to create algorithms.
3. must possess:
- knowledge of the application of quantum algorithms for solving practical problems.
4. must demonstrate the ability and readiness:
- to deepen their knowledge in the field of quantum computing and cryptography independently.

Contents

Contents of the discipline
Topic 1. Elements of information theory.
lecture (4 hours):
practical lesson (4 hours):
Topic 2. Basic quantum logic operations.
lecture (4 hours):
practical lesson (4 hours):
Topic 3. Basic quantum algorithms.

lecture (6 hours):
practical lesson (6 hours):

Exemplary literature
Basic literature: 1. Davydov, A.S. Quantum mechanics: study guide. 3rd edition, stereotyped. SPb .: BHV-Petersburg, 2011. p.704. http://znanium.com/bookread.php?book=351130 2. Zhuk, A.P. Data protection: Study guide / Zhuk, A.P., Zhuk, E.P., Lepeshkin, O.M., Timoshkin, A.I. - 2-nd edition - M.: Information center RIOR: Research center «Infra-M», 2015. – p.392 : http://znanium.com/bookread.php-book=474838 Electronic resource. 3. Ignatov, A.N. Nanoelectronics. State and prospects of its development [electronic resource]: Study guide / Ignatov, A.N. M. FLINTA, 2012. p.360. http://znanium.com/bookread.php?book=455222 Additional literature: 1. Holevo, A.S. Introduction into the quantum information theory. M. MOSCOW CENTER FOR CONTINUOUS MATHEMATICAL EDUCATION, 2002. 2. Nielsen, M., Chang, I. Quantum computing and quantum information. M., Mir, 2006. 3. Valiev, K.A. Kokin, A.A. Quantum computers: hopes and reality. Izhevsk, Regular and Chaotic Dynamics, 2001. 4. Kilin, S.Ya. Quantum information. UFN, 1999, №5, t.169, pp.507-526. 5. Menskiy, M.B. Quantum mechanics: new experiments, new applications and new formulations of old questions. UFN, 2000, №6, t.170, pp.631-648. Internet resources: KFU www.kpfu.ru Scientific search system www.scopus.com Quantum computers and quantum computing aakokin.chat.ru/qc.htm Free encyclopedia ru.wikipedia.org Electronic library www.ekniga.ru

Course name Modern methods of synthesis and investigation of nanostructures				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
2	18 weeks	Elective	5	In-class- 56, Self-study - 106

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

Learning outcomes
As the result of the mastering of the discipline the student: 1. Must know:

The regularities and physical chemical process models of the nano-objects reception;
Types and characteristics of nano-objects and nanomaterials, characteristics of physical chemical processes and their synthesis;
Possess theoretical knowledge about physical causes of the so called size effects, which reveal in various characteristics of nano-structures.
Modern research methods of nano-structures.
Possess the knowledge about practical application of nanotechnologies.
2. Must be able to:
Choose the necessary experiment methods for the reception of this or that information about the characteristics of nano-cultures.
Use information means and technologies, including original scientific monographs and articles for the interpretation of received results.
On the basis of the outcomes of the modelling experiments work out the plan of nanomaterials reception, criteria of choice of nanotechnology variants;
Be able to state the received information and present the results of physical researches.
3. Must posess:
The skills of application of the received knowledge in the field of nanotechnologies for the solution of professional tasks
4. Must demonstrate the ability and readiness to carry out:
System scientific analysis of professional problems of different difficulty level;
The works with laboratory equipment and modern scientific equipment;
Physical and chemical experiment.

Contents

Topic 1. Modern conceptions about the peculiarities of nano-structures' construction, methods of their analysis.
Lectures (15 hour(s)):
Practical lessons (14 hour(s)):
Topic 2. Technology of reception of nano-materials, their characteristics and application.
Lectures (14 hour(s)):
Practical lessons (14 hour(s))):

Exemplary literature

The basic literature:
Gusev, A.I. Nano-materials, nano-structures, nano-technologies / A.I. Gusev, 2nd edition, corrected. – M.: Physmatlit, 2009. – 416 p. http://e.lanbook.com/books/element.php?pl1_id=2173.
Barybin, A.A., Tomilin V.I., Shapovalov V.I. Physical-technological grounds of macro-, micro- and nano-electronics. – M: Physmatlit, 2011. – 784 p. http://e.lanbook.com/view/book/5258.
Stoikov, I.I. The grounds of nano-technology and nano-chemistry: [student's book]/ I.I. Stoikov, G.A. Evtugin; The Kazan (Volga region) Federal University, Chemical University of Butlerov. – Kazan: [The Kazan University], 2010. – 236 p.: ill.
7.2. Additional literature:
Eliseev, A.A. Functional nano-materials: student's book for the students of higher courses, studying at the specialization 020101 (011000) – Chemistry / A.A. Eliseev, A.V. Lukashin; edited by acad. Yu.D. Tretiakov. – Moscow: Physmatlit, 2010. – 452 p.: colorfully illustrated, portraits, tables.
Raster electronic microscopy for nano-technologies: methods and application / edited by U. Zhu, Zh.L. Uang; transtated from English. – M.: Binom. Laboratory of knowledge, 2013 – 582 p. http://e.lanbook.com/books/element.php?pl1_id=8689

7.3. Internet-resources:
NanoNewsNet – nano-technologies news – http://subscribe.ru/catalog/science.news.nanonews
Internet-magazine about nano-technologies – http://www.nanojournal.ru/
Popular science website about nanotechnologies – http://kbogdanov5.narod.ru/
National nano-technology net – http://www.rusnanonet.ru/
Website of nano-technological community Nanometer – http://www.nanometer.ru

Course name Femtosecond Spectroscopy of Condensed Matter				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
3	16 weeks	optional	5	Classwork – 56, self-study - 70

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

Learning outcomes

As the result of the mastering of the discipline the student:
1. Must know:
- The generation methods of light impulses of femtosecond duration, principles of laser work in the regime of mode synchronization, interaction of electromagnetic emission with the substance in the conditions of ultimately short duration of impulses and high power density;
2. Must be able to:
- Investigate the building principle of particular laser systems, generating impulses of picosecond and femtosecond duration, use in practice the measure methods of characteristics, as well as manipulations with the duration and spectrum contents of super-short light impulses;
3. Must manage:
- Conceptions about the building principles of experiment installations on the base of laser sources, generating super-short light impulses. Possess the skills of work with experiment laser technics and methodology of research and practical supplements with its application.
4. Must demonstrate the ability and readiness:
To take active creative part in the development and building of experiment installations for the research, performed with the application of the sources of femtosecond light impulses, analyze the received results.

Contents

Contents of the discipline
Topic 1. The bases of laser physics. Basic conceptions.
Lecture (2 hour(s)):
Topic 2. Optics of super-short light impulses.

Lecture (4 hour(s)):
Practical lesson (4 hour(s)):
Topic 3. Generation methods of super-short laser impulses: regime of mode synchronization.
Lecture (4 hour(s)):
Practical lesson (4 hours):
Topic 4. Other generation methods of super-short light impulses.
Lecture (4 hour(s)):
Topic 5. Principles and methods of parameter administration of super-short light impulses: time compression, strengthening, reorganization on the wavelength.
Lecture (4 hour(s)):
Practical lesson (4 hour(s)):
Topic 6. Methods of the measurement of the parameters of super-short light impulses.
Lecture (2 hour(s)):
Practical lesson (4 hour(s)):
Topic 7. Elementary excitations of condensed environments, the dynamics of which is studied by methods of femtosecond spectroscopy. Model of connected thermal tanks.
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 9. Processes of non-radiative relaxation of electronic excitations. Electron-vibrational interaction. Effect of narrow throat.
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 10. Process of excitation and relaxation of elementary excitations of collective coherent conditions, such as superconductivity and wave of charging density.
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 11. Processes of excitation and relaxation in magnet sequenced environments. Photo-induced precession of magnetization. Excitation and coherent control of magnons. Photo-induced reversion of magnetization.
Practical lesson (4 hour(s)):

Exemplary literature

Basic literature:
1. Demtreder, V. Modern laser spectroscopy (student's book)/V. Demtreder, (translation from English) – Dolgoprudny: Intellect, 2014. – 1070 p.
2. Kozlov, S.A., Samartsev, V.V. The bases of femtosecond optics. M.: Physmatlit. – 2009. – 292 p.
3. Samartsev, V.V. correlative photons of their application / V.V. Samartsev. – M.: Physmatlit, 2013. – 167 p.

Additional literature:
1. Akhmanov, S.A., Vysloukh, V.A., Chirkin A.S. Optics of femtosecond impulses. – M.: Science. – 1988. – 312 p.
2. Akhmanov, S.A. Methods of nonlinear optics in spectroscopy of light diffusing: Active spectroscopy of light diffusing / S.A. Akhmanov, N.I. Koroteev. – M.: Science, 1981. – 453 p.

Internet-resources:
Wikipedia – free encyclopedia http://ru.wikipedia.org/
Everything for a student http://www.twirpx.com/
Scientific library of N.I. Lobachevsky http://www.kpfu.ru/main_page-p_sub=5056
Electronic-library system http://ibooks.ru
Electronic books http://eknigi.org/

The title of the course Physics of condensed condition				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
3	16 weeks	optional	5	Classwork – 56, self-study - 70

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	3	16 weeks	optional

Learning outcomes

As the result of the mastering of the discipline the student:
1. Must know:
- The essence of existing theoretical models of quasi-particles;
2. Must be able to:
- Interpret physical processes and phenomena of condensed substance;
3. Must manage:
- Methods of definition of the main parameters of quasi-particles.
4. Must demonstrate the ability and readiness:
- To examine experimental data and theoretical approaches in interconnection;
- To critically consider the approaches, existing in literature;
- To build the logics of evidence and substantiations of this or that hypothesis with maximally full analysis of alternative variants;
- To organize and plan physical researches;

To independently pose concrete problems of scientific researches in physics (according to the profile of master program) and solve them with the help of modern technics, equipment, information technologies with the application of newest native and foreign experience.

Contents

Contents of the discipline
Topic 1. Introduction
Lecture (2 hour(s)):
Topic 2. Characteristic of molecules and interaction between particles. Phonons.
Lecture (4 hour(s)):
Practical lesson (4 hour(s)):
Topic 3. Elementary excitations in electronic Fermi-liquid. Quasi-particles in superconductors.
Lecture (6 hour(s)):
Practical lesson (6 hour(s)):
Topic 4. Heavy fermions. Elementary excitations in semiconductors.
Lecture (6 hour(s)):
Practical lesson (6 hour(s)):
Topic 5. Plasmons, holons, spinons, magnons
Lecture (4 hour(s)):

Practical lesson (6 hour(s)):
Topic 6. Bose-Einstein condensation. Methods of BEC reception and its main physical features.
Lecture (4 hour(s)):
Practical lesson (4 hour(s)):
Topic 7. Composite particles.
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):

Exemplary literature
Basic literature: Nano-materials, nano-structures, nano-technologies / A.I. Gusev. – 2nd edition, corrected. – Moscow: Physmatlit, 2009. – 416 p.: ill.; 22sm. – Bibliography at the end of the chapter. – Name index: p.406-407. – Subject index: p. 408-414. Eremin, M.V. Microscopic models in condensed environments / M.V. Eremin // - Kazan, the Kazan University. – 2011. – 111p. http://kpfu.ru/docs/F1043614157/Eremin_Posobie_2011.doc Minco, N.I. Reception methods and characteristics of nano-objects [electronic resource]: student's book / N.I. Minco, V.V. Strokova, I.V. Zhernovsky, V.M. Nartsev. – 2nd edition, stereotypical. – M. FLINTA, 2013. – 165 p. – ISBN 978-5-9765-0326-7 http://znanium.com/bookread.php-book=46288 Additional literature: Kittel, Ch. Introduction to the physics of solid body. M.: Science, 1978. Zayman, G. Theory principles of solid body. M.: Science, 1974. Kitel, Ch. Quantum theory of solid body. Zayman, G. Models of disorder M.: Mir, 1982. Parsonidge, N., Stavy, L. Disorder in crystals. M.: Mir, 1982. March, N., Parinello, M. Collective effects in solid body and liquids. M.: Mir, 1986. Blakemore, G. Physics of a solid body. M.: Mir, 1988. Internet-resources: Wikipedia http://ru.wikipedia.org/wiki/Физика_конденсированного_состояния Lectures of ИТФ http://chair,itp.ac.ru/index.php-sub=curriculum/tks/mat_tks Lectures of MSU http://www.issp.ac.ru/univer/2004/prog.html Lectures of MSU 1 http://shg.phys.msu.ru/educat/cond_mat/Lecture_10.pdf Lectures of SFU HTTP://FILES.LIB.SFU-KRAS.RU/EBIBL/UMKD/120/U_LECTURES.PDF

The title of the course Structure-dynamic characteristics of condensed environments				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
3	16 weeks	optional	2	Classwork – 28, self-study - 44

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

		practical lessons	

Learning outcomes
As the result of the mastering of the discipline the student: 1. Must know: - Understand the main results of translation dynamics of molecules and macromolecules in the most representative classes of molecular systems (polymer, heterogenic etc.); 2. Must be able to: - Compare different characteristics of molecular system, received either by different methods or by different methods within one method; 3. Must possess: - Analysis skills of primary experimental outcomes and their comparison with theoretical accounts or models 4. Must demonstrate the ability and readiness: - To examine experimental data and theoretical approaches in interconnection; - To critically consider the approaches existing in literature; - To build the logics of evidence and substantiations of this or that hypothesis with maximally full analysis of alternative variants; - To organize and plan physical researches; To independently pose concrete problems of scientific researches in physics (according to the profile of master program) and solve them with the help of modern technics, equipment, information technologies with the application of newest native and foreign experience.

Contents
Contents of the discipline Topic 1. Structure and dynamics of molecules in solutions and fusions of polymers. *Lecture (3 hour(s)):* *Practical lesson (4 hour(s)):* Topic 2. Characteristics of molecular mobility and super-molecular structure in three-dimensional macromolecular systems. *Lecture (3 hour(s)):* *Practical lesson (2 hour(s)):* Topic 3. Dynamics in polyphase systems with phase exfoliation *Lecture (2 hour(s)):* *Practical lesson (4 hour(s)):* Topic 4. Phase condition and molecules' dynamics in limited environments *Lecture (4 hour(s)):* *Practical lesson (4 hour(s)):* Topic 5. Features of structure-dynamic characteristics in bio-systems *Lecture (2 hour(s)):*

Exemplary literature
Basic literature: Spectrum analysis methods. Practical guide: Student's book / V.I. Vasileva, O.F. Stoyanova, I.V. Shkutina, S.I. Karpov – 2014. – 416 p. – 1st Edition. – ISBN 978-5-8114-1638-7. – Publishing house "Lan'". Electronic library system. http://e.lanbook.com/books/element.php?pl1_id=50168 Nuclear magnet resonance in inorganic and coordination chemistry. Solutions and liquids / M.A.

Fedotov. – 2010. – ISBN: 978-5-9221-1202-4. – 384 p. – Publishing house “Physmatlit”. Electronic library system.
Nuclear magnet resonance in inorganic and coordination chemistry. Solutions and liquids / M.A. Fedotov. – 2010. – ISBN: 978-5-9221-1202-4. – 384 p. – Publishing house “Physmatlit”. Electronic library system. http://e.lanbook.com/books/element.php?pl1_id=2151

Additional literature

Phase transitions of polymer systems in external fields: Student’s book / S.A. Vshivkov. – 2nd Edition, corrected and supplemented. – 2013. – 368 p. – ISBN 978-5-8114-1529-8. – Publishing house “Lan’” Electronic library system. http://e.lanbook.com/books/element.php?pl1_id=30431
Nuclear physics. Theoretical bases and laboratory practicum: Student’s book / V.E. Grakov, S.A. Maskevich and oth.; edited by A.P. Klishenko. – M.: INFRA-M; Pl.: New edition, 2011. – 333 p. 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 U.S.A.) - 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
THE BASES OF X-RAY DIFFRACTION - http://ssrc.inp.nsk.su/CKP/lections/X-ray_structure_analysis.pdf

The title of the course Structure-dynamic characteristics of condensed environments				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
3	16 weeks	optional	2	Classwork – 28, self-study - 44

Enrollment requirements	**Exam type (oral, written, course work, etc.)**	**Educational methods (lectures, seminars, etc.)**	**Course coordinator**
	credit	Lectures, practical lessons	S.B. Orlinsky

Learning outcomes
As a result of the mastering of the discipline the student: 1. Must know: - Flow diagrams and mode of functioning of the main types of spectrometers EPR; 2. Must be able to: - Use methods of impulse EPR;

3. Must manage:
- Methods of stationary and impulse EPR-spectrometroscopy
4. Must demonstrate ability and readiness:
To work with modern spectrometers EPR

Contents

Topic 1. Introduction
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 2. SHF-resonators.
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 3. Generators SHF.
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 4. Time measuring of spin-lattice relaxation. Impulse spectrometer EPR.
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 5. Spectrometers of acoustic paramagnet resonance.
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 6. Characteristics of spectrometers' construction.
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 7. Measurements of magnetic field, microwave frequencies, temperature.
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):

Exemplary literature

Basic literature:

Zaripov, M.M. The bases of the theory of electronic paramagnetic resonance spectra in crystals: a course of lectures. / M.M. Zaripov // - Kazan: the Kazan State University, 2009. – 212 p.: ill.; 21 sm. – Bibliography: p.205-206 (204 names). – ISBN 978-5-98180-707-7, 225.
Physics-chemistry bases of the technology of building materials: Methodological book / Ya.N. Kovalev. – M.: SRC Infra-M; Pl.: New edition, 2012. – 285 p.: ill.; 60x90 1/16. – (Higher education). (cover) ISBN 978-5-16-005580-0, http://znanium.com/bookread.php-book=278683
Electronic equipment and machines: Student's book / F.A. Tkachenco. – M.: INFRA-M; Pl.: New edition, 2011. – 682 p.: ill.; 60x90 1/16. – (Higher education). (cover) ISBN 978-5-16-004658-7 http://znanium.com/bookread.php?book=209952

Additional literature:

Electronic paramagnetic resonance of ions of transient groups, Volume II / A. Abgaram, B.Blini, Volume II, Mir, Moscow, 1973, 349 p.
Altshuler, S.A., Kozyrev, B.M. Electronic paramagnetic resonance, M.: Science, 1972.
Searching system Scopus for the students' search of articles about the development of applied methods of EPR-spectroscopy in the present times. www.scopus.com
Gassanov, L.G., Lipatov, A.A., Markov, V.V., Mogilchenco, N.A. Solid-state devices SHF in communication engineering. M., 1998.

Internet-resources:

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

Program Easyspin – http://www.easyspin.org/
Program Mathlab – www.mathworks.com/
Publisher's website Elsevier – http://elsevierscience.ru/
Bruker company's website – http://www.bruker-biospin.de
Collective usage center of KPFU – http://www.kpfu.ru/main_page-p_sub=11446

The title of the course Laser materials				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
3	16 weeks	optional	3	Classwork – 42, self-study - 66

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

Learning outcomes

As a result of the mastering of the discipline the student:
1. Must know:
- The fundamentals of physics of different types of condensed active laser environments: crystals and glasses, activated by rare-earth ions, crystals activated by ions of iron groups, crystals with color centers;
- Physics and features of non-linear optic and electro-optic crystals;
- The main principles of selection of active laser environment for the lasers working by continuous and impulse pumping, in continuous regime, regimes of free generations, modulation of good quality and mode synchronization;
- The main approaches for single-minded search of new laser environments.
2. Must be able to:
- Apply the received knowledge for the work with different types of lasers and laser systems;
- Use the methods of physical research of quantum electronics materials;
- Use the received knowledge for the development of laser system of different purpose, considering the characteristics of active laser environments, non-linear and electro-optic crystals.
3. Must possess:
- The skills of work with laboratory models of different lasers, modulators and deflectors, as well as control-measurement equipment;
- The skills of calculation of elementary laser systems;
- The skills of conduction of a physical experiment.
4. Must demonstrate the ability and readiness:
- To apply the received knowledge for the work with different types of lasers and laser systems;

- To use the main measure equipment, applied in quantum electronics, measure the main parameters of laser radiation, pose and solve elementary experimental problems in quantum electronics;
Use the methods of physical research of the materials of quantum electronics.

Contents

Contents of the discipline
Topic 1. Physic-chemical parameters of laser materials
Lecture (4 hour(s)):
Topic 2. Laser crystals and glasses, activated by rare-earth ions
Lecture (4 hour(s)):
Practical lesson (2 hour(s)):
Topic 3. Processes of transformation of excitation energy in activated materials
Lecture (4 hour(s)):
Practical lesson (2 hour(s)):
Topic 4. Crystals for tunable lasers, activated by ions of iron group
Lecture (4 hour(s)):
Practical lesson (2 hour(s)):
Topic 5. Crystals with coloring centers
Lecture (4 hour(s)):
Practical lesson (4 hour(s)):
Topic 6. Active environments for lasers with semiconductor pumping
Lecture (4 hour(s)):
Practical lesson (2 hour(s)):
Topic 7. Non-linear optic and electro-optic crystals
Lecture (4 hour(s)):
Practical lesson (2 hour(s)):

Exemplary literature

Basic literature:
Demtreder V., Modern laser spectroscopy (student's book) / V.Demtreder, (translation from English) – Dolgoprudny: Intellect, 2014. – 1071 p.
Salekh, B., Teikh, M. Optics and photonics. Principles and applications: Student's book in 2 volumes, V.1: Dolgoprudny, LLC Publishing house "Intellect", 2012 – 760 p.
Salekh, B., Teikh, M. Optics and photonics. Principles and applications: Student's book in 2 volumes, V.2: Dolgoprudny, LLC Publishing house "Intellect", 2012 – 764 p.
Additional literature:
Konstantinova, A.F. and oth. Optical characteristics of crystals, Minsk.: "Science and technics", 1995 – 302 p.
Blistanov, A.A. Crystals of quantum and non-linear optics, M.: "MISIS", 2000 – 432 p. Basic transitions of polymer systems in external fields: Student's book / S.A. Vshivkov
Internet-resources:
American Physical Society (APS) http://libress.kpfu.ru/proxy/http://pubs.acs.org
Elsevier (Science Direct) http://libress.kpfu.ru/proxy/http://www.sciencedirect.com/
Scopus http://libress.kpfu.ru/proxy/http://www.scopus.com/home.url
Internet resources of the KFU library http://portal.kpfu.ru/main_page?p_sub=8224
Electronic library system Znanium http://znanium.com

The title of the course Technics of nuclear-magnetic resonance				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
3	16 weeks	optional	3	Classwork – 42, self-study - 66

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

Learning outcomes

As a result of the mastering of the subject the student:
1. Must know:
The working principles of spectrometers NMR
2. Must be able to:
Calculate the sensitiveness of spectrometers
3. Must possess:
Practical skills of the processing of spectra.
4. Must demonstrate the ability and readiness:
To prepare a spectroscopic experiment

Contents

Topic 1. Introduction. The subject of the course. Conception about magnetic resonance.
Lecture (4 hour(s)):
Practical lesson (2 hour(s)):
Topic 2. The data unit of spectrometers NMR. Tank circuit as a transformer of impedance. Parameters of real circuit.
Lecture (4 hour(s)):
Practical lesson (2 hour(s)):
Topic 3. Noise. Spectrum characteristics of noise. Noise-factor. Measurement of noise-factor.
Lecture (4 hour(s)):
Practical lesson (2 hour(s)):
Topic 4. Detecting in radio-spectroscopy.
Lecture (4 hour(s)):
Practical lesson (2 hour(s)):
Topic 5. Analogue-digital transformation.
Lecture (4 hour(s)):
Practical lesson (2 hour(s)):
Topic 6. Fourier-spectroscopy. Correlation between impulse and stationary signals.
Lecture (4 hour(s)):
Practical lesson (2 hour(s)):
Topic 7. Wideband equipment of HF band. 50-o. technics. Concordance of the transmitter, data unit and receiver. Measurement of the reflection coefficient
Lecture (4 hour(s)):

Practical lesson (2 hour(s)):

Exemplary literature

Basic literature:

Sergeev, N.A., The fundamentals of quantum theory of nuclear magnetic resonance: monograph / N.A. Sergeev, D.S. Ryabushkin. – M.: Logos, 2013. – 272 p. http://znanium.com/bookread.php-book=469025

Fundamentals of chain theory: Student's book / G.N. Arsenyev, V.N. Bondarenko, I.A. Chepurnov; edited by G.N. Arsenyev. – M.: ID FORUM: INFRA-M, 2011. – 448 p. http://znanium.com/bookread.php-book=224548

Sergienko, A.B. Digital processing of signals: student's book. – 3rd edition. – St. Petersburg.: BHV – Petersburg, 2011. – 768 p. http://znanium.com/bookread.php-book=354905

Additional literature:

Molchanov, A.P. A course of electro-technics and radio-technics: student's book / A.P. Molchanov, P.N. Zanadvornov. – 4th edition, stereotype. – St.P.: BHV-Petersburg, 2011. – 608 p. http://znanium.com/bookread.php-book=354909

Nuclear magnetism / A. Abraham; translation from English edited by G.V. Skortsky. – Moscow: Publishing house of foreign literature, 1963. – 551 p.

Electronic technics: Student's book / M.V. Galperin. – 2nd edition, corrected and supplemented. – M.: ID FORUM: SRC INFRA-M, 2014. – 352 p. http://znanium.com/bookread.php-book=420238

Rannev, E.V. Digital quadrature receiver of nuclear magnetic resonance signal of low resolution / Internet magazine \"Sociology of science\", edition 1, 2014. http://znanium.com/bookread.php-book=477399

Projecting of analogue and digital gadgets: Student's book / V.S. Titov, V.I. Ivanov, M.V. Bobyr. – M.: SRC INFRA-M, 2014. – 143 p. http://znanium.com/bookread.php-book=4227206

Guk, M. Apparatus means of local nets: Encyclopedia / Mikhail Guk. St.P. and oth.: St.Peterspurg, 2002. 572 p.: ill. Alphabetical index: p.544-572.

Novikov, Yu.V. Local nets: architecture, algorithms, projecting / Yu.V. Novikov, S.V. Kondratenko. M.: ECOM, 2002. 311 p.

Kenin, A.M. Manual of a system administrator / A. Kenin. Sankt Petersburg: BHV-Petersburg, 2006. 451 p.

Internet-resources:

American physical society – www.aps.org
The Kazan University – www.Kpfu.ru
Scientific search system – www.scopus.com
Free encyclopedia – ru.wikipedia.org
Electronic library – www.ekniga.ru

The title of the course High frequency electronic paramagnetic resonance / double electronic nuclear resonance in nano-structures

Semester	Duration	Course type	ETCS	Student workload
3	16 weeks	optional	2	Classwork – 28, self-study - 44

Enrollment requirements	Exam type (oral, written, course work, etc.)	Educational methods (lectures, seminars, etc.)	Course coordinator
	credit	Lectures, practical lessons	S.B. Orlinsky

Learning outcomes

As a result of the mastering of the discipline the student:
1. Must know:
The main types of technical solutions by creation of HF spectrometers
2. Must be able to:
Evaluate the possibilities of nano-structure synthesis by different methods and predict the result
3. Must manage:
To take in the quality difference of technics and abilities of high frequency (HF) EPR/DENR
4. Must demonstrate the ability and readiness:
To apply HF EPR/DENR and demonstrate its advantages comparing with other methods of nano structure research

Contents

Topic 1. Introduction
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 2. Impulse HF EPR spectrometers
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 3. Impulse HF DENR spectrometers
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 4. Nano-structures
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 5. Nano-crystals ZnO.
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 6. Dynamic polarization of nucleus
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 7. HF EPR/DENR in biology
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):

Exemplary literature

Basic literature:
1. Zaripov, M.M. The fundamentals of theory of spectra of electronic paramagnetic resonance in crystals: a course of lectures / M.M. Zaripov // - Kazan: the Kazan State University, 2009. – 212 p.: ill.; 21 sm. – Bibliography: p.205-206 (24 names). ISBN 978-5-98180-707-7,

255.
2. Electronic gadgets and equipment: Student's book / F.A. Tkachenko. – M.: INFRA-M; Pl.: New knowledge, 2011. – 682 p.: ill.; 60x90 1/16. – (Higher education). (cover) ISBN 978-5-16-004658-7 http://znanium.com/bookread.php?book=209952
3. Bezborodov, Yu.N. Methods of control and diagnostics of exploitation characteristics of lubrication materials in parameters of thermos-oxidant stability and temperature firmness [electronic resource]: monograph / Yu.N. Bezborodov, B.I. Kovalsky, N.N. Malysheva, A.N. Sokolnikov, E.G. Maltseva. – Krasnoyarsk: The Siberian Federal University, 2011. – 366 p. ISBN 978-5-7638-2225-0. http://znanium.com/bookread.php-book=442965

7.2. Additional literature:

1. Electronic paramagnetic resonance of ions of transition groups, Vol. II / A. Abraham, B. Blini, Vol. II, Mir, Moscow, 1973, 349 p.
2. Altshuler, S.A., Kozyrev, B.M. Electronic paramagnetic resonance, M.: Science, 1972.
3. Search system Scopus for the students' search of articles about the development of applied in the course methods of EPR-spectroscopy in the present time. www.scopus.com

7.3. Internet-resources:

Search system Scopus – http://www.scopus.com/home.url
Program Balls & Sticks – http://toycrate.org/bs/index.html
Program Easyspin – http://www.easyspin.org/

The title of the course Optics of nano-size systems				
Semester	**Duration**	**Course type**	**ETCS**	**Student workload**
3	16 weeks	optional	2	Classwork – 28, self-study - 44

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

Learning outcomes

As a result of the mastering of the discipline the student:

1. Must know:
- The fundamental of the methods of synthesis of nano-particles and nano-structures;
- Physical principles of photonics and optics of nano-structures;
- The fundamentals of description methods of optical characteristics of nano-particles and nano-structures;
- Quantum-size effects in nano-particles;
- Optical characteristics of metal, dielectric and semiconductor nano-particles;
- The main characteristics of nano-materials;
- The characteristics of nano-structures and composites, allowing to correctly chose the types of optic materials for the development of equipment of different purpose;

- The existing and perspective application fields of nano-particles and nano-structures.

2. Must be able to:
- To carry out comparative analysis of optical characteristics of nano-size structures on the basis of their structure, size and material;
- To plan experimental research of optical characteristics of nano-size structures;
- To carry out experimental research of the characteristics of nano-particles, nano-structures and composites on their basis by the methods of optical spectroscopy;
- To improve independently in one of the directions of the optics of nano-size structures.

3. Must manage:
- The main physic-chemical development principles of new optic nano-structured materials;
- The methods of analysis of optical characteristics of nano-structured materials on their spectrum and other parameters;
- The main definition methods of size, form, and mutual disposition of nano-size objects

4. Must demonstrate the ability and readiness:
- To apply the received knowledge for the analysis of optical characteristics of nano-size systems on the base of their structure, size and material, modelling of optical characteristics of nano-particles;
- To plan experimental research of optic characteristics of nano-size systems;
- To carry out experimental research of the characteristics of nano-particles, nano-structures and composites on their base with the methods of optical spectroscopy;

To improve oneself independently in one of the direction of optics of nano-size particles.

Contents

Contents of the discipline
Topic 1. Nano-structures. Reception methods and modern application fields of nano-materials.
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 2. Nano-plasmonics
Lecture (4 hour(s)):
Practical lesson (4 hour(s)):
Topic 3. Metamaterials
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 4. Optical characteristics of semiconductor nano-particles and structures
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 5. Optical characteristics of dielectric nano-particles
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):
Topic 6. Photon crystals
Lecture (2 hour(s)):
Practical lesson (2 hour(s)):

Exemplary literature

Basic literature

Klimov,V.V., Nano-plasmonics. – M.: Physmatlit, 2010. – 480 p.
Navotny, L., Khekht, B., The fundamentals of nano-optics. – M.: Physmatlit, 2009. – 484 p.

Grundman, M. The fundamentals of physics of semiconductors. Nanophysics and technical supplements. – M.: Physmatlit, 2012. – 778 p.

Additional literature:

Peter, Yu., Cardona, M. The fundamentals of semiconductor physics. – M.: Physmatlit, 2002. – 560 p.

Kozlov, S.A., Samartsev, V.V. The fundamentals of femtosecond optics. M.: Physmatlit. – 2009. – 292 p.

Internet-resources:

American Physical Society (APS) http://libress.kpfu.ru/proxy http://pubs.acs.org
Elsevier (Science Direct) http://libress.kpfu.ru/proxy/http://www.sciencedirect.com
Scopus http://libress.kpfu.ru/proxy/http://www.scopus.com/home.url
Internet resources of the library of the KFU http://portal.kpfu.ru/main_page-p_sub=8224
Electronic-library system Znanium http://znanium.com