CONTENT

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ AKTP/12	**Course name:** Applications of Quantum Field Theory in Contemporary Condensed Matter Physics
Course type, scope and the method: **Course type:** Lecture **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 28 **Course method:** distance, present	
Number of ECTS credits: 5	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: To successfully complete the course, the student must demonstrate sufficient theoretical knowledge of the methods of quantum field theory used in the study of phase transitions in condensed matter. The credit evaluation of the subject takes into account the following student workload: direct learning - 2 credits, study of recommended literature - 1 credit, exam preparation - 2 credits.	
Learning outcomes: To acquaint the students with modern methods of quantum field theory and their application in the condensed matter physics.	
Brief outline of the course: Hypothesis of scaling (critical scaling) in thermodynamics; Ising model and thermodynamics of ferromagnetism; Scaling of Green functions; Landau theory; Fluctuation theory and critical behaviour; Foundations of quantum field theory; Physical quantum fields and their equations – Dirac equations, Klein-Gordon equaiton; Quantization of fields; Evolution operator; S-matrix; Green functions and generation functional; T- and N-products; Wick theorems; Feynman diagrammatic technique; Functional form of Green functions, generating functional and statistical sum; Phase transitions; Universal behaviour of statistical sum in the vicinity of phase transition point; Landau fluctuation theory for description of phase transitions; Anomalous scaling; Renormalization of Landau theory; Epsilon-expansion and calculation of renormalization constants; Renormalization group and differential equations for Green functions; Asymptotic scaling solutions in the region of large scales,determination of their stability; Calculation of anomalous and critical exponents.	
Recommended literature: 1. N.N. Bogolyubov, D.V. Shirkov: Quantum fields, Nauka, Moskva, 2005 (in russian) 2. A.N. Vasilev: Renormalization group in Critical Behavior Theory and Stochastic Dynamics Chapman & Hall/CRS , Boca Raton London New York Washington D.C., 2004.	
Course language: slovak, english	

Notes:
The course is carried out in the full-time form, or if necessary remotely in the MS Teams environment.

Course assessment
Total number of assessed students: 2

N	P
0.0	100.0

Provides: prof. RNDr. Michal Hnatič, DrSc.

Date of last modification: 22.11.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ PVS/04	**Course name:** Author's patents, discoveries, software

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: Per study period:
Course method: distance, present

Number of ECTS credits: 2

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Patent filed, invention, software product created.

Learning outcomes:
The PhD student demonstrates the ability to create an innovative product in a given scientific field, or with impact on an interdisciplinary scale or in technical practice.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 48

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ COK/22	**Course name:** Certified training course

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: Per study period:
Course method: distance, present

Number of ECTS credits: 4

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Completion of a certified professional/training course.

Learning outcomes:
The PhD student acquires up-to-date scientific knowledge, develops the capabilities of scientific work and familiarizes himself with the methodologies of making scientific knowledge available. He confronts his own knowledge and skills with other course participants, develops the abilities of peer discussion in the given scientific field.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 7

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ CM/22	**Course name:** Citation in monograph
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week:** **Per study period:** **Course method:** distance, present	
Number of ECTS credits: 8	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: Obtained citation registered in SCI or Scopus.	
Learning outcomes: Obtaining a citation demonstrates broad and very well-founded scientific knowledge in the researched field, based on the ability to formulate research questions, to reflect on a scientific problem in such a way that generates new knowledge. At the same time, a citation in an indexed source demonstrates the competence to communicate new knowledge, which is a significant contribution to scientific knowledge, at the highest expert level.	
Brief outline of the course:	
Recommended literature:	
Course language:	
Notes:	
Course assessment Total number of assessed students: 0	

abs	n
0.0	0.0

Provides:	
Date of last modification: 08.11.2022	
Approved: prof. Ing. Martin Orendáč, DrSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ CZC/22	**Course name:** Citation in scientific journal published abroad

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: **Per study period:**
Course method: distance, present

Number of ECTS credits: 4

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Obtained citation in a foreign scientific journal.

Learning outcomes:
Obtaining a citation demonstrates broad and very well-founded scientific knowledge in the researched field, based on the ability to formulate research questions, to reflect on a scientific problem in such a way that generates new knowledge. At the same time, a citation in an indexed source demonstrates the competence to communicate new knowledge, which is a significant contribution to scientific knowledge, at the highest expert level.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 8

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ CDC/22	**Course name:** Citation in scientific journal published in the country of residence
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week: Per study period:** **Course method:** distance, present	
Number of ECTS credits: 2	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: Records of citations in the central register of records of publication activity.	
Learning outcomes: A citation in a peer-reviewed scientific journal indicates the quality of a doctoral student's publication activity and the acceptance of his publishing activity in the domestic scientific community.	
Brief outline of the course: Study of literature with a focus on the chosen issue of publication output.	
Recommended literature:	
Course language:	
Notes:	
Course assessment Total number of assessed students: 0	
abs	n
0.0	0.0
Provides:	
Date of last modification: 12.10.2022	
Approved: prof. Ing. Martin Orendáč, DrSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ SCI/22	**Course name:** Citation registered in Science Citation Index

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: Per study period:
Course method: distance, present

Number of ECTS credits: 8

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Records of citations in the central register of records of publication activity.

Learning outcomes:
A citation in a peer-reviewed scientific journal indicates the quality of a doctoral student's publication activity and the acceptance of his publishing activity in the scientific community.

Brief outline of the course:
Study of literature with a focus on the chosen issue of publication output.

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 93

abs	n
100.0	0.0

Provides:

Date of last modification: 12.10.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ SPAV/22	**Course name:** Co-investigator of the applied research project

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: Per study period:
Course method: distance, present

Number of ECTS credits: 5

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Co-investigator of the applied research project

Learning outcomes:
The PhD student demonstrates the ability to participate in teamwork, to bring his own contribution to the solution of the project objective of applied research and to take responsibility for assigned tasks. By solving an applied research project, he acquires the ability to implement the project objective according to the established procedure, to follow the project schedule, to coordinate his own activities with colleagues, to participate in the creation of applied research outputs. The PhD student gains valuable experience from the practical course of a grant project with a focus on applied research.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 16

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ SIG/22	**Course name:** Co-worker of project supported by internal grant schemes (VVGS)

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: **Per study period:**
Course method: distance, present

Number of ECTS credits: 3

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Co-worker of project supported by internal grant schemes (VVGS)

Learning outcomes:
The PhD student demonstrates the ability to participate in teamwork, to bring his own contribution to the solution of the project objective within the internal grant system at UPJŠ. By solving the internal VVGS grant, he acquires the ability to implement the project plan according to the established procedure, adhere to the project schedule, coordinate his own activities with colleagues, and participate in the creation of outputs. The PhD student gains valuable experience from the practical course of the grant project.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 16

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ SMPR/04	**Course name:** Co-worker of project supported by international grant schemes
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week: Per study period:** **Course method:** distance, present	
Number of ECTS credits: 15	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: Membership in the research team of an international project.	
Learning outcomes: Active involvement by solving a specific task within a team of international project solvers. The PhD student demonstrates the ability to work in a team, take responsibility for the assigned task, adhere to the time schedule and fulfill the project outputs. The PhD student gains personal experience from the implementation of an international project, participation in its key stages, creation of measurable outputs, grant funding of science	
Brief outline of the course:	
Recommended literature:	
Course language:	
Notes:	
Course assessment Total number of assessed students: 129	

abs	n
100.0	0.0

Provides:	
Date of last modification: 08.11.2022	
Approved: prof. Ing. Martin Orendáč, DrSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ SDPR/22	**Course name:** Co-worker of project supported by national grant schemes

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: **Per study period:**
Course method: distance, present

Number of ECTS credits: 10

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Co-investigator of the domestic project

Learning outcomes:
The PhD student demonstrates the ability to participate in teamwork, to bring his own contribution to the solution of the project objective and to take responsibility for the assigned tasks. By solving the domestic project, he acquires the ability to implement the project intention according to the established procedure, to follow the project schedule, to coordinate his own activities with colleagues, to participate in the creation of outputs. The PhD student gains valuable experience from the practical course of the grant project.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 45

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ODZP/14	**Course name:** Defence of Doctoral Thesis
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week: Per study period:** **Course method:** distance, present	
Number of ECTS credits: 30	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: The Dissertation thesis is the result of the student's own scientific research. It must not show elements of academic fraud and must meet the criteria of correct research practice defined in the Rector's Decision no. 21/2021, which lays down the rules for assessing plagiarism at Pavel Jozef Šafárik University in Košice and its constituents. Fulfillment of the criteria is verified mainly in the process of supervising and in the process of the thesis defense. Failure to do so is grounds for disciplinary action.	
Learning outcomes: The Dissertation thesis has elements of a scientific work and the student demonstrates extensive mastery of the theory and professional terminology of the field of study, acquisition of knowledge, skills and competences in accordance with the declared profile of the graduate of the field of study, as well as the ability to apply them in an original way in solving selected problems of the field of study. The student demonstrates the ability of independent scientific work in terms of content, formal and ethical aspects. Further details of the Dissertation thesis are determined by Directive no. 1/2011 on the essential prerequisites of final theses and by the Study Rules of Procedure at UPJŠ in Košice for doctoral studies. The doctoral student demonstrated the ability and readiness for independent scientific and creative activity in the field of study of philology in accordance with the expectations of the relevant qualification framework and the profile of the graduate.	
Brief outline of the course:	
Recommended literature:	
Course language:	
Notes:	
Course assessment Total number of assessed students: 134	

N	P
0.75	99.25

Provides:
Date of last modification: 08.11.2022
Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ DDS/15	**Course name:** Domains and Domain Walls
Course type, scope and the method: **Course type:** Lecture **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 28 **Course method:** present	
Number of ECTS credits: 3	
Recommended semester/trimester of the course:	
Course level: II., III.	
Prerequisities:	
Conditions for course completion: To successfully complete the course, the student must demonstrate sufficient understanding of basic concepts of magnetism, anisotropy, statics and dynamics of domain structure. Knowledge of basic concepts is required. The student must be able to actively understand the content of the curriculum continuously during the semester, so that the acquired knowledge can be actively and creatively used in solving specific problems. The minimum limit for passing the exam is to obtain 51% of the total score, which takes into account all required activities with relevant weight. Rating scale: A - 91% -100% points, B - 81% -90% points, C - 71% -80% points, D - 61% -70% points, E - 51% -60% points.	
Learning outcomes: After completing the lectures and the final evaluation, the student will demonstrate adequate knowledge of the course standard, which is defined by the brief content of the course and the recommended literature. Theoretical knowledge of the content of the subject allows him to fully participate in the further study of specialized subjects that are related to the assignment of his dissertation. Can find connections between the domain structure of the investigated materials in relation to their crystallographic structure, the method of their preparation or their thermal or mechanical processing. The acquired knowledge will also facilitate the performance of the scientific part of the dissertation.	
Brief outline of the course: Time schedule of the subject contents is updated in electronic board in AiS2 sw. The subject content is focused in the following main topics: 1. The concept of domain structure 2. Experimental techniques for the study of domain structure 3. Examples of domain structures - their calculation 4. Material parameters determining domain structure, anisotropies 5. Domain walls - types, calculations 6. Experimental techniques for the study of statics and dynamics of domain walls 7. Statics of a domain wall - its potential, critical field 8.-9. Domain wall dynamics - basic models and parameters determining DS dynamics. 10. Domain wall dynamics in small magnetic fields - DS dynamics in adiabatic mode.	

11. Dynamics of the domain wall in high magnetic fields - structure of the domain wall, its changes, interaction with phonons
12. Maximum speed of the domain wall - Schlomann and Walker limit
13. Spintronics - application of domain wall promotion in spintronics (Race-Track memory, Logic based on domains and domain walls, sensors), current problems and the future.

Recommended literature:
1. B.D. Cullity, C.D. Graham, „Introduction to magnetic materials", John Wiley & Sons, New Jersy (2009) 2. S. Chikazumi, Physics of Ferromagnetism, Oxford University Press, USA (2009) 3. S. Tumanski, Handbook of Magnetic Measurements, CRC Press (2011) 4. N. A. Spaldin, Magnetic Materials: Fundamentals and Device Applications, Cambridge University Press (2003)

Course language:
slovak, english

Notes:
Lectures can be done at presence form or online form using MS Teams. Education form is updated at the begining of the subject.

Course assessment
Total number of assessed students: 7

A	B	C	D	E	FX	N	P
71.43	0.0	28.57	0.0	0.0	0.0	0.0	0.0

Provides: prof. RNDr. Rastislav Varga, DrSc.

Date of last modification: 26.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ VPZP/22	**Course name:** Elaboration of reviewer report

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: **Per study period:**
Course method: distance, present

Number of ECTS credits: 3

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Elaboration of reviewer report

Learning outcomes:
The PhD student demonstrates broad and scientifically based knowledge in the field of study, as well as knowledge of a wide range of methods and approaches. Demonstrates the ability to critically assess a professional problem and its proposed solution, as well as to evaluate it and possibly recommend another solution. He applies knowledge and skills from the field of pedagogical sciences to his own field.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 0

abs	n
0.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: CJP/ AJD1/07	**Course name:** English Language for PhD Students 1
Course type, scope and the method: **Course type:** Practice **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 28 **Course method:** distance, present	
Number of ECTS credits: 2	
Recommended semester/trimester of the course: 1.	
Course level: III.	
Prerequisities:	
Conditions for course completion: Completion of e-course English for PhD Students (lms.upjs.sk), consultations (1-3). Written assignments - Professional/Academic CV, Short Academic Biography.	
Learning outcomes: The development of students´ language skills - reading, writing, listening, speaking; improvement of their linguistic competence - students acquire knowledge of selected phonological, lexical and syntactic aspects; development of pragmatic competence - students acquire skills for effective and purposeful communication, with focus on Academic English and English for specific/professional purposes, level B2.	
Brief outline of the course: Specific aspects of academic and professional English with focus on correct pronunciation, vocabulary development (noun and verb collocations, phrasal verbs, prepositional phrases, word-formation, formal/informal language, etc.), selected aspects of English grammar (prepositions, grammar tenses, passive voice, etc.), academic writing (professional/academic CV, Short Academic Biography).	
Recommended literature: Moore, J.: Oxford Academic Vocabulary Practice. OUP, 2017. Kolaříková, Z., Petruňová, H., Timková, R.: Angličtina v akademickom prostredí – cvičebnica. Košice, Vydavateľstvo ŠafárikPress, 2021. Tomaščíková, S., Rozenfeld, J. Developing Academic English in Speaking and Writing. Vydavateľstvo ŠafárikPress, 2021. McCarthy, M., O´Dell, F.: Academic Vocabulary in Use. CUP, 2008. Štepánek, L., J. De Haff a kol.: Academic English-Akademická angličtina. Grada Publishing, a.s., 2011. Armer, T.: Cambridge English for Scientists. CUP, 2011. lms.upjs.sk	
Course language: English, level B2 according to CEFR	
Notes:	

Course assessment
Total number of assessed students: 780

N	Ne	P	Pr	abs	neabs
0.0	0.0	45.64	0.0	54.23	0.13

Provides: Mgr. Zuzana Kolaříková, PhD.

Date of last modification: 06.09.2024

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: CJP/AJD2/07	**Course name:** English Language for PhD Students 2
Course type, scope and the method: **Course type:** Practice **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 28 **Course method:** distance, present	
Number of ECTS credits: 3	
Recommended semester/trimester of the course: 2.	
Course level: III.	
Prerequisities:	
Conditions for course completion: Test, oral exam in accordance with the exam requirements (available at the web-site of the LTC and in MS TEAMS)	
Learning outcomes: The development of students´ language skills - reading, writing, listening, speaking, improvement of their linguistic competence - students acquire knowledge of selected phonological, lexical and syntactic aspects, development of pragmatic competence - students can efectively use the language for a given purpose, with focus on Academic English and English for specific/professional purposes, level B2.	
Brief outline of the course: Academic communication (self-presentation, presenting at scientific meetings and conferences). Specific aspects of academic and professional English with focus on vocabulary development (formality, academic word-list), English grammar (passive voice, nominalisatio), language functions (expressing opinion, cause/effect, presenting arguments, giving examples, describing graphs/charts/schemes, etc.). Cross-language interference.	
Recommended literature: Moore, J.: Oxford Academic Vocabulary Practice. OUP, 2017. Kolaříková, Z., Petruňová, H., Timková, R.: Angličtina v akademickom prostredí (cvičebnica). UPJŠ Košice, 2021. Tomaščíková, S., Rozenfeld, J. Developing Academic English in Speaking and Writing. Vydavateľstvo ŠafárikPress, 2021. McCarthy, M., O´Dell, F.: Academic Vocabulary in Use. CUP, 2008. Štepánek, L., J. De Haff a kol.: Academic English-Akademická angličtina. Grada Publishing, a.s., 2011. Armer, T.: Cambridge English for Scientists. CUP, 2011.	
Course language: B2 level according to CEFR	
Notes:	

Course assessment
Total number of assessed students: 774

N	Ne	P	Pr	abs	neabs
0.26	0.0	94.06	1.03	4.52	0.13

Provides: Mgr. Zuzana Kolaříková, PhD.

Date of last modification: 05.02.2024

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ EMFNT/12	**Course name:** Experimental Methods of Low-Temperature Physics
Course type, scope and the method: **Course type:** Lecture **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 28 **Course method:** present	
Number of ECTS credits: 3	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	

Conditions for course completion:

In order to complete the course, each student has to show and manifest a sufficient understandig of all fundamental terms, concepts and methods used in low and ultralow temperature physics and techniques. Necessary condition to pass the course, except the presence on the lectures is also an active participation on disccusions during the courses, where they are proving their konwledge. Elaboration and presentation of the report on a topic from field of low temperature physics and techniques selected by teacher.

Minimal threshold to pass the course is 51% from total amount of evaluation points, taking into accout all requested activities with relevant weight.

Evalution scale: A - 91%-100% points, B - 81%-90% points, C - 71%-80% points, D - 61%-70% points, E - 51%-60% points.

Credit evaluation takes into account: the presence on the lectures (1 credit), self-study of recommended literature (1 credit), preparation and the report presentation (1 credit).

Learning outcomes:

By completing the course, the students will understand and know the fundamental physical principles and methods how to achieve low and ultralow temperatures including knowledge on technical realisation of the experimental facilities which allow to achieve this. Evenmore, the students will learn how to handle the cryo-liquids, how to operate the superconducting magnets, they will understand fundamentals of the vacuum techniques and the leak detection. They will acquire infomation on methods and specifications of measurements of physical quanitities at low and very low temperatures. Finally, they will obtain information on applications of low temperature physics and techniques in praxis, which maybe used in their everyday life and job.

Brief outline of the course:

Physical principles of cooling below ambient temperature. Liquefaction of gases and manipulation with cryogenic liquids. Fundamentals of vacuum techniques and leak detection of vacuum systems. Physical principles and methods of cooling to low and ultra low temperatures. Measurements of low and ultra low temperatures, temperature scale definition. Physical properties of condensed matters at low temperatures. Construction of low temperature refrigerators and apparatures. Low temperature electronics and measurements of physical quantities at low and ultra low temperatures. Applications of low and ultra low temperature physics and techniques.

Recommended literature:
F. Pobell: Matter and Methods at Low Temperatures, Springer Verlag Berlin 1995.
Ch. Enss and S. Hunklinger: Low Temperature Physics, Springer Verlag Berlin 2005.
L. Skrbek a kolektív: Fyzika nízkych teplot, matfyz press, Praha 2011
G.K. White and P.J. Meeson: Experimental Techniques in Low Temperature Physics, Clarendon Press, Oxford 2002.
Š. Jánoš: Fyzika nízkych teplôt, Alfa, Bratislava 1982.
J. Jelínek a Z. Málek: Kryogénní technika, SNTL Paraha 1982.

Course language:
Slovak, English

Notes:
Lectures are given in a person form. In the case of a need the lectures can be delivered by on-line (MS Teams, etc).

Course assessment
Total number of assessed students: 15

N	P
0.0	100.0

Provides: RNDr. Peter Skyba, DrSc.

Date of last modification: 22.11.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ DKZU/22	**Course name:** Home Conference with Foreign Participation

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: Per study period:
Course method: distance, present

Number of ECTS credits: 5

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Active participation in a national conference with foreign participation.

Learning outcomes:
By actively participating in a scientific conference, the PhD student demonstrates a high degree of ability to identify, evaluate, and apply correct scientific methods or research methodology in his scientific field. He demonstrates the ability to reflect on a specific scientific problem by using the latest approaches and applying them critically. Demonstrates competence to use existing theories and concepts in an innovative way, as well as generate new original scientific knowledge and communicate research results to a wider audience by adequate means and through Slovak or a foreign language.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 64

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ NEM/04	**Course name:** Implementation of new experimental methodology
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week: Per study period:** **Course method:** distance, present	
Number of ECTS credits: 15	
Recommended semester/trimester of the course: 8.	
Course level: III.	
Prerequisities:	
Conditions for course completion:	
Learning outcomes:	
Brief outline of the course:	
Recommended literature:	
Course language:	
Notes:	
Course assessment Total number of assessed students: 100	
abs	n
100.0	0.0
Provides:	
Date of last modification:	
Approved: prof. Ing. Martin Orendáč, DrSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ZC/22	**Course name:** International Journal

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: **Per study period:**
Course method: distance, present

Number of ECTS credits: 8

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Publication accepted in a foreign journal as an author/co-author.

Learning outcomes:
By publishing in a foreign journal as an author/co-author, the PhD student demonstrates a high level of ability to identify, evaluate, and apply correct scientific methods or research methodology. He demonstrates the ability to reflect on a scientific problem by using the latest approaches and applying them critically. He demonstrates the competence to use existing theories and concepts in an innovative way, as well as to generate new original scientific knowledge, which he can publish according to the highest qualitative and ethical standards of the field. The PhD student demonstrates the ability to critically evaluate and respond to reviewers' suggestions, to finalize his own ideas.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 4

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ ZSP1/22	**Course name:** International Study Stay less than 30 Days

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: **Per study period:**
Course method: distance, present

Number of ECTS credits: 5

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Completion of a foreign study stay lasting less than 30 days.

Learning outcomes:
By completing a shorter study stay, the PhD student demonstrates the ability to reflect on research problems and work critically with sources at an expert level and in an interdisciplinary context, while being able to generate new knowledge. He is able to actively communicate at an expert level in more than one language. He acts as a responsible independent scientist, works independently and in a group with the aim of pushing the boundaries of knowledge and transferring them to other areas of research, to practice and to the wider public. He can competently argue and explain his ideas.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 29

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ZSP2/22	**Course name:** International Study Stay more than 30 Days

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: Per study period:
Course method: distance, present

Number of ECTS credits: 10

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Completion of a foreign study stay lasting more than 30 days.

Learning outcomes:
By completing the study stay, the PhD student demonstrates the ability to reflect on research problems and work critically with sources at an expert level and in an interdisciplinary context, while being able to generate new knowledge. He is able to actively communicate at an expert level in more than one language. He acts as a responsible independent scientist, works independently and in a group with the aim of pushing the boundaries of knowledge and transferring them to other areas of research, to practice and to the wider public. He can competently argue and explain his ideas

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 12

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ MKZ/22	**Course name:** International abroad conference

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: Per study period:
Course method: distance, present

Number of ECTS credits: 10

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Active participation in an international conference abroad.

Learning outcomes:
By actively participating in an international scientific conference abroad, the phD student demonstrates a high level of ability to identify, evaluate, and apply correct scientific methods or research methodology in his scientific field. He demonstrates the ability to reflect on a specific scientific problem by using the latest approaches and applying them critically. Demonstrates competence to use existing theories and concepts in an innovative way, as well as generate new original scientific knowledge and communicate research results to a wider audience by adequate means and through a foreign language.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 105

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ VKFKL/22	**Course name:** Introduction to Condensed Matter Physics

Course type, scope and the method:
Course type: Lecture / Practice
Recommended course-load (hours):
Per week: 3 / 1 **Per study period:** 42 / 14
Course method: present

Number of ECTS credits: 6

Recommended semester/trimester of the course: 1., 3.

Course level: III.

Prerequisities:

Conditions for course completion:
To successfully complete the course, the student must demonstrate sufficient understanding of the basic terms, concepts, and applications of Condensed Matter Physics. During semester, the student must continuously master the content of the curriculum so that he can actively and creatively use the acquired knowledge to design and perform actual experiments during the exercises in laboratories. To obtain credits, students are required to design an experiment in Condensed Matter Physics under tutor's guidance using the experimental infrastructure of the Centre of Low Temperature Physics, carry it out successfully and pass an oral examination. (Examples of experiments: Reciprocal lattice visualization by RHEED, Fermi contour visualization by quasiparticle interference in STM, superconducting energy gap estimation by tunneling spectroscopy, Andreev reflection in point contact spectroscopy, phonon and electron contribution to heat capacity, magnetic domain visualization by Hall probe etc.) The credit evaluation of the course considers the following student workload: direct teaching (3 credits), self-study (2 credits), practical exercises in block mode (2 credits), individual consultations and assessment (1 credit). The minimum threshold for completing the course is to obtain at least 50% of the total score, using the following rating scale: A (90-100%), B (80-89%), C (70-79%), D (60- 69%), E (50-59%), F (0-49%).

Learning outcomes:
After completing the lectures and exercises, students will have sufficient skills and knowledge enabling independent solution of a wide range of both, traditional and novel scientific problems in Condensed Matter Physics.

Brief outline of the course:
1. Crystal structure. Operations of symmetry. Basic types of lattices. Base and crystal structure. Primitive cell. Indexes of crystal planes. Simple crystal structures. Non-ideal crystal structures.
2. Diffraction on crystal and reciprocal lattice. Interacting beam. Bragg´s condition. Laue´s conditions. Experimental diffraction techniques. Evald construction. Amplitude of the scattered wave. Brillouin zones. Fourier analysis of the base. Analysis of the diffraction pattern.
3. Crystal binding. Crystals of inert gasses. Van der Walls-London interaction. Repulsive interaction. Equilibrium lattice constants. Cohession energy. Ionic crystals. Madelung energy. Determination of Madelung constant. Covalent crystals. Crystals with hydrogen bonds. Atomic radii.

4. Phonons – crystal vibrations. Vibrations in lattices with one atom in primitive cell. First Brillouin zone. Approximation of continuous medium.Determination of force constants from experiment. Lattice with two atoms in primitive cell. Quantization of lattice vibrations. Quasi-momentum of phonon. Inelastic scattering of neutrons on phonons.
5. Phonons – thermal properties. Specific heat. Planck´s distribution. Einstein model. Density of modes in one and three dimensions. Debye model of lattice specific heat. Specific heat of crystals and glasses. Anharmonic vibrations in crystals - thermal extensibility. Scattering processes - thermal conductivity.
6. Free electron Fermi gas. Energy levels and density of electronic states in one-dimensional case. Influence of temperature on Fermi-Dirac distribution. Three-dimensional electron gas. Specific heat of electron gas. Electric conductivity and Ohm´s law. Motion of electrons in magnetic fields. Classical and quantum Hall efect.
7. Energy bands. Model of nearly free electrons. Origin and magnitude of the forbiden band. Bloch functions. Kronig-Penney model. Wave equation of electron in periodic potential. Approximative solution close to zone boundary. Number of electron states in a band. Metals and insulators.
8. Semiconductors. Forbiden band for semiconductors. Equations of motion. Holes. Effective mass. Silicon and germanium as examples of semiconductors. Concentration of charge carriers. Impurity conductivity. Thermal ionization of donors and acceptors. Thermoelectric phenomena in semiconductors.
9. Superconductivity. Experimental findings. Meissner effect. Isotopic effect. Specific heat of superconductor. London equation. Penetration depth. Coherence length. BCS theory of superconductivity. Superconductors of I. and II. type. Josephson tunneling in superconductor. Fixed and alternating Josepson effect. Macroscopic quantum interference.
10. Diamagnetism and paramagnetism. Langevin equation for a diamagnetic system. Classical calculation of polarization of a paramagnet. Quantum theory of paramagnetism. Hund´s rules. Splitting of energy levels in a crystal field. Adiabatic demagnetization of paramagnetic salts. Nuclear demagnetization. Paramagnetic susceptibility of conductive electrons.
11. Ferromagnetism and antiferromagnetism. Curie temperature and exchange integral. Temperature dependence of saturated magnetization. Saturated magnetization at 0 K. Model of spin waves. Magnetic scattering of neutrons. Antiferromagnetic ordering. Ferromagnetic domains. Energy of anisotropy. Origin of domains. Thickness of domain walls. Hysteresis loop of a ferromagnet. Coercitive field. Hysteresis loop of a single-molecule magnet.
12. Unconventional magnetic systems. Influence of the absence of translational symmetry on magnetic properties of three-dimensional magnetic systems. Spin glasses. Geometrical and spin frustration. Macroscopic degeneration of the ground state. Spin liquid and spin ice. Residual entropy. Single-domain magnetic nanoparticles.

Recommended literature:

Ch. Kittel: Introduction to Solid State Physics, 7th edition, John Wiley and sons, New York 1996.
H.Ibach, H.Luth: Solid-State Physics, Springer, Berlin 1996.
M Tinkham: Introduction to Superconductivity, 2-nd edition, Mc Graw- Hill, New York 1996.
S. H. Simon: The Oxford Solid State Basics, Oxford University Press, Oxford 2013
https://solidstate.quantumtinkerer.tudelft.nl/

Course language:

Slovak, English

Notes:

The course comprises onsite lectures and exercises. If necessary, online lectures and consultations will be provided via MS Teams.

Course assessment
Total number of assessed students: 5

abs	n
100.0	0.0

Provides: prof. Ing. Martin Orendáč, DrSc., Mgr. Tomáš Samuely, PhD., univerzitný docent

Date of last modification: 28.07.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ DC/22	**Course name:** Local journal
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week: Per study period:** **Course method:** distance, present	
Number of ECTS credits: 6	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: Publication accepted in a national journal as author/co-author.	
Learning outcomes: By publishing in a national journal as an author/co-author, the PhD student demonstrates a high level of ability to identify, evaluate, and apply correct scientific methods or research methodology. He demonstrates the ability to reflect on a scientific problem by using the latest approaches and applying them critically. He demonstrates the competence to use existing theories and concepts in an innovative way, as well as to generate new original scientific knowledge, which he can publish according to the highest qualitative and ethical standards of the field. The PhD student demonstrates the ability to critically evaluate and respond to reviewers' suggestions, to finalize his own ideas.	
Brief outline of the course:	
Recommended literature:	
Course language:	
Notes:	
Course assessment Total number of assessed students: 2	
abs	n
100.0	0.0
Provides:	
Date of last modification: 08.11.2022	
Approved: prof. Ing. Martin Orendáč, DrSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ MKS I/04	**Course name:** Macroscopic quantum systems I

Course type, scope and the method:
Course type: Lecture
Recommended course-load (hours):
Per week: 2 **Per study period:** 28
Course method: present

Number of ECTS credits: 5

Recommended semester/trimester of the course: 1.

Course level: III.

Prerequisities:

Conditions for course completion:
To successfully complete the course, the student must demonstrate sufficient knowledge of the nature of macroscopic quantum phenomena based on Bose-Einstein condensation and quantum fluids. At the same time, students will develop a project in the form of a presentation on a given topic, in which they will deal with macroscopic quantum phenomena close to the topic of their dissertation. Credit evaluation of the course takes into account the following student workload: direct teaching - 1 credit, self-study of recommended supplementary literature - 1 credit, project preparation based on scientific and journal literature - 2 credits, preparation for the test - 1 credit. The minimum limit for obtaining the evaluation is 50% of the point evaluation of the test and at least 50% of the points for the quality of the project.

Learning outcomes:
After completing lectures and self-study, the student will gain detailed knowledge in the field of macroscopic quantum phenomena. They will expand their knowledge from the course of Low Temperature Physics from the FKL master's study on the properties of liquid and solid helium, superfluidity, knowledge of Bose-Einstein condensation in magnetic systems, concepts of Luttinger and spin liquid in magnetic systems, topological excitations in spin systems. The acquired knowledge will facilitate his work on the scientific part of the dissertation.

Brief outline of the course:
1.-3. Selected chapters about superfluidity in 4He, 3He and in their solutions.
4. Solid helium, properties of quantum crystals.
5. Quantum cavitation and evaporation in liquid helium.
6.-7. Spin dynamics and magnetic resonance in superfluid 3He. Magnetic superfluidity and persistent processing domain in 3He-B. Bose-Einstein condensation of magnons in superfluid 3He.
8. Nuclear magnetism. Nanokelvin temperatures.
9. Spin liquid in spin chains and frustrated spin systems.
10.-12. Dimerized spin systems and their energy spectrum. Spin ladder, alternating chain. Luttinger liquid and Bose-Einstein condensation of magnetic excitations.

Recommended literature:
L. Skrbek a kol., Fyzika nízkych teplôt, Matfyzpress, MFF KU Praha, 2011.
C. Enss, S. Hucklinger, Low-Temperature Physics, Springer, 2005.

K.H. Bennemann, J.B. Ketterson, The Physics of liquid and solid Helium, A Wiley Interscience Publication, 1978.
D.R. Tilley, J. Tilley, Superfluidity and Superconductivity, Adam Hilger ltd., Bristol, 1990.
E.R. Dobbs, Helium Three, Oxford Science publications, 2000.
U. Schollwock, J. Richter, D.J.J. Farnell, R.F. Bishop (Eds.), Quantum Magnetism, Lect. Notes Phys. 645, Springer, Berlin Heidelberg, 2004.
E. Čižmár, Energy gap in the excitation spectra of one-dimensional magnets, habilitation thesis, UPJŠ, 2016.
scientific journals

Course language:
Slovak, English

Notes:
Teaching is carried out in person or on-line using MS Teams. Form of teaching specified by the teacher, updated continuously.

Course assessment
Total number of assessed students: 33

N	P
0.0	100.0

Provides: doc. RNDr. Erik Čižmár, PhD.

Date of last modification: 21.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ MKS II/22	**Course name:** Macroscopic quantum systems II

Course type, scope and the method:
Course type: Lecture
Recommended course-load (hours):
Per week: 1 **Per study period:** 14
Course method: present

Number of ECTS credits: 2

Recommended semester/trimester of the course: 1., 3.

Course level: III.

Prerequisities:

Conditions for course completion:
Sucessfull passing the course requires presentation of adequate knowledge of concepts, phenomena and laws from Condensed Matter Physics related to the formation of macroscopic quantum states. More specifically, understanding of superconductivity, principle of operation of superconducting quantum interference detector, Abrikosov - Suhl resonance in the Kondo lattice, Bose – Einstein condensation, quantum tunneling in single molecule magnets and quantum Hall effect is required. The number of credits reflects the extent of the course (1 hour of lectures), studying the recommending literature, consultations, preparation for the exam and the exam itself. Threshold for obtaining evaluation is related to obtaining 50% from evaluation scheme which is specified as follows:
A 100-91%
B 90-81%
C 80-71%
D 70-61%
E 60-50%
Fx 49-0%

Learning outcomes:
Successfull passing the course and the exam enables students to obtain deep physical insight in quantum systems in which macroscpic quantum states are formed. These include predominantly superconducting heavy fermion systems, Bose – Einstein condensate in dilute gases, macroscopic quantum tunnelling, the quantum Hall effect and its applications, the superconducting quantum interference device (SQUID) and its applications.

Brief outline of the course:
1.week: Brief review of the basics of superconductivity (formation of the Cooper pairs condensate and its properties). Tunnelling of electrons and Cooper pairs (Josephson effect). Relationship between superconducting current and phase difference at a weak / tunnel connection between two superconductors. Influence of the external magnetic field on phase change.
2. week: Influence of external magnetic field on the phase change between two superconductors. Current passing through two parallel superconducting tunnel junctions. Interference between two parallel superconducting currents. Basics of the DC SQUID operation.

3. week: Construction of a DC SQUID and creation of various gradiometers for measuring very small magnetic fields. Use of SQUID - magnetometers in research, in the search for magnetic anomalies and in medical diagnostics.
4. week: Strongly interacting Fermi gas and its renormalization to free electron model. Simple 2D model of electron correlations. Interaction between conductivity and localized electrons in metals, Kondo phenomenon. Change of electrical and magnetic properties, and change of heat capacity related to the Kondo effect.
5. week: Origin of the Abrikosov - Suhl resonance in the Kondo lattice, origin of heavy-fermion systems. Basic properties of heavy-fermion systems (electrical, magnetic, thermal). RKKY interaction in metallic magnetic systems. Interplay between Kondo and RKKY interactions.
6. week: superconductivity in 4f- and 5f- heavy-fermion systems (examples). Other examples of unconventional superconductivity (high temperature superconductors, superfluid 3He). Pairing and order parameter in various unconventional superconductors.
7. week: Applications of superconductivity. Transmission of electricity. Possibilities of using superconductivity in transport (superfast trains). Use of superconductivity in medicine - diagnostic and imaging techniques. Use of superconductivity in research (accelerators, fusion reactors, condensed matter physics). Possibilities of using superconductivity in electronics.
8. week: Bose - Einstein condensation. Properties of bosons and fermions, examples of bosonic and fermionic systems. Principles of BE condensation. Examples of BE condensates (e.g. 4He, 3He). Diluted gases, the de Broglie wavelength. Formation of coherence in diluted gases.
9. week: Laser cooling of diluted gases. 1D and 3D cooling, influence of the Doppler effect. Magnetic capture of cooled gas. Further cooling of the condensate via evaporation. Examples of condensates, achieved results and parameters (temperature, density of condensate). Methods of BE condensate detection and properties of BE condensates
10. week: Macroscopic quantum tunnelling in single molecule magnets. Influence of hyperfine interactions and magnetic coupling among single molecule magnets on the probability of quantum tunnelling. Experimental possibilities of the detection of quantum tunnelling.
11. week: Quantum Hall effect. Hall effect in metals and semiconductors. Quantization of electron energy in magnetic field, Landau levels and their degeneration. Quantization of Hall resistance in 2D electron gases.
12. week: Observation of the fractional quantum Hall effect. Explanation of the fractional quantum Hall effect using the so-called composite fermions. Influence of magnetic field on 3D systems – the de Haas - van Alphen effect.

Recommended literature:

W. Buckel, R. Kleiner: Superconductivity, Wiley-WCH, Weinheim (2004).
Scientific articles.
K.N.Shrivastava; Introduction to Quantum Hall Effect; Nova Science, Hauppauge, N.Y. 2002
S.Takagi; Macroscopic Quantum Tunneling; Cambridge U. Press, n.Y. 2002

Course language:
Slovak, English

Notes:
The course is given in attendance form, if a need arises online form will be adopted using MS Teams.

Course assessment
Total number of assessed students: 5

abs	n
100.0	0.0

Provides: doc. RNDr. Karol Flachbart, DrSc.

Date of last modification: 27.07.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ MVV1/07	**Course name:** Magnetic Materials with Outstanding Properties
Course type, scope and the method: **Course type:** Lecture **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 28 **Course method:** present	
Number of ECTS credits: 5	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: To successfully complete the course, the student must demonstrate sufficient understanding of the basic phenomena in the field of magnetic materials. Knowledge of basic concepts of magnetism, its origin, properties and division of magnetic materials is required. During the semester, the student must continuously acquire selected magnetic materials, from their preparation to application. The condition for obtaining credits is the presentation of selected magnetic material together with an oral exam, which consists of theoretical questions. The credit evaluation of the course takes into account the following student workload: direct teaching (3 credits), preparation of the presentation (1 credit) and evaluation (1 credit).	
Learning outcomes: After completing the lectures, the student will gain a general overview of the magnetic properties of matter, various types of progressive magnetic materials and the application of soft and hard magnetic materials.	
Brief outline of the course: 1.Magnetism of matter. Paramagnetism, diamagnetism, ferromagnetism and ferrimagnetism. 2. Macroscopic properties of ferromagnets. Domain structure. 3. Magnetic processes. Applications of soft magnetic materials. 4. Magnetic properties of iron-based alloys. 5. Magnetic losses and their separation. 6. Magnetic properties of cobalt and nickel based alloys and their applications. 7. Structure and magnetic properties of soft magnetic ferrites and their applications. 8. Structure and magnetic properties of hard magnetic ferrites and their applications. 9. Structure, preparation and magnetic properties of amorphous alloys. 10. Structure, preparation and magnetic properties of nanocrystalline alloys. 11. Magnetic particles, ferrofluids, magnetic cooling 12. Basic experimental methods of measuring magnetic materials.	
Recommended literature: S. Chikazumi: Physics of Magnetism, J.Willey and Sons, Inc. New York, London, Sydney, 1997. D. Jiles: Introduction to magnetism and magnetic materials, Chapman&Hall, London, New York, Tokyo, Melbourne, Madras, 1991 R. C. O'Handley: Modern Magnetic Materials, Principles and Applications, J.Willey and Sons, Inc. New York, 1999, Modern scientific literature.	

Course language:
slovak, english

Notes:
Teaching is carried out in person or remotely using the MS Teams tool. The form of teaching is specified by the teacher at the beginning of the semester and continuously updated.

Course assessment
Total number of assessed students: 47

N	P
0.0	100.0

Provides: doc. RNDr. Ján Füzer, PhD., RNDr. Ivan Škorvánek, CSc.

Date of last modification: 22.11.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ MGCH/22	**Course name:** Magnetochemistry

Course type, scope and the method:
Course type: Lecture / Practice
Recommended course-load (hours):
Per week: 2 / 1 **Per study period:** 28 / 14
Course method: present

Number of ECTS credits: 5

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:

Continuous active acquisition of the subject is required during the course of Magnetochemistry, which is necessary for independent mastery of individual tasks in self-study and in solving specific homework assignments. During the semester, the student will get a theoretical project based on the study of foreign journal literature (understanding of a specific scientific article and based on it the elaboration and presentation). Another condition for completing the course is active participation in lectures and seminars. In the exercises, the student will get a concrete idea of how the experimental data are analyzed. Subsequently, the student independently analyzes the experimental data of the selected magnetic compound in the frame of two to three home projects and presents the results of the analysis at a joint meeting. Another condition for obtaining credits is successful completion of the exam from the theoretical part in the form of an extensive oral discussion, where the student demonstrates understanding of basic concepts and relationships between them, finding connections and understanding the course as a coherent whole logically built on the basis of gradual incorporation of individual interactions. The minimum threshold for passing the course is successful completion of self-study projects and individual assignments during the semester and mastering the final oral exam by more than 50 percent.

Credit evaluation takes into account the scope of direct teaching (2 credits), self-study of recommended literature and preparation of presentation (1 credit) elaboration of home assignments (1 credit), consultations and evaluation (1 credit)

Learning outcomes:

After completing the course, the students will gain a basic perspective, which will allow them to sufficiently orient themselves in the current scientific literature focused on quantum magnetism. Based on the acquired theoretical knowledge and practical experience, they will be able to independently study magneto-structural correlations in electrically non-conductive materials and identify their magnetic state, which is important especially for quantum technologies but also for practical applications such as magnetic cooling especially at low temperatures. Based on the acquired knowledge, discussions and the creation of individual projects, they will also learn the basics of critical thinking in this field.

Brief outline of the course:

1. Development of theories of the structure of atom. Bohr model of atom. Electron in the hydrogen atom. Wave functions and orbitals. Quantum numbers. Magnetomechanical parallelism. Spin of electron. Atoms with higher number of electrons. Electron-electron interactions. Ground state of atom. Hund's rules. Terms. Multiplets.
2. Atom in magnetic field: I. Magnetic properties of atom. Paramagnet. Macroscopic properties of paramagnetic materials. Specific heat – Schottky maximum, experimental techniques of heat capacity measurements. Magnetization - Brillouin function, experimental techniques of magnetization measurements.
3. Atom in magnetic field II: Magnetic susceptibility – Curie law, experimental techniques of susceptibility measurements. Electron paramagnetic resonance. Field induced magnetic moment of filled electronic shells. Diamagnetic susceptibility. Pascal's constants.
4. Atom in crystal field. Weak, medium, strong crystal field. Medium crystal field: Ions with one electron in the unfilled subshell, ions with two and more electrons in the unfilled subshell. Freezing of angular momentum. Jahn-Teller effect.
5. Spin-orbit coupling in the first and second order of perturbation theory. Spin Hamiltonian. Spin Hamiltonian for tetragonal symmetry of the medium crystal field. Kramers theorem. Thermodynamics of the system of paramagnetic ions in crystal field. Specific heat. Magnetization. Magnetic susceptibility. Electron paramagnetic resonance of the systems with crystal field.
6. Magnetic correlations. Exchange coupling. Molecule of hydrogen. Heisenberg Hamiltonian. Exchange pathway. Direct and undirect exchange interaction. Anderson model of superexchange. Goodenough-Kanamori empirical rules.
7. Spatial arrangement of exchange pathways. Cluster. Chain. Layer. Low-dimensional magnetic systems.Three-dimensional magnetic systems. Phase transitions. Correlation length. Ehrenfest's theorems. Long range order. Short-range order. Magnetic dimer: Specific heat. Magnetization. Magnetic susceptibility. Electron paramagnetic resonance.
8. Anisotropy in the exchange interactions. Sources of anisotropy. Dipolar interaction. Heisenberg model. Ising model. XY model.
9. Analysis of the structure of selected compounds based on Ni(II) and Cu(II) ions. Determination of exchange pathways and the influence of crystal field. Suggestion of appropriate magnetic models for the compounds. Using scientific software Origin each student will perform analysis of experimental data of temperature dependence of specific heat of Ni(II) compound, i.e. separation of lattice contribution, calculation of magnetic entropy, comparison with expected theoretical values.
10. Application of theoretical prediction of chosen model for magnetic specific heat of Ni(II) compound and considering the correctness of the model, explanation origin of deviations of experimental data from the applied model .
11. Analysis of magnetic susceptibility of Ni(II) compound-subtraction of diamagnetic contribution, calculation of magnetic moment and g-factor. Application of Curie-Weiss law, then fitting exp. data by a model prediction yielding g-factor and strength of crystal field.
12. Comparison of results obtained from the analysis of specific heat and susceptibility. Then magnetization is calculated and compared with experimental data. Students will make hypothesis about the ground state of the system and they will suggest new experiments on the studied compound.
13. Comparison of the results obtained by individual students which provides information about the influence of individual approach, as number of particular analyses, which test robustness of obtained material parameters etc. Monitoring and examination of elaboration of analogic home projects on Cu(II) compound, accompanied with consultations.

Recommended literature:

1.R.L. Carlin, A.J. Duyneveldt: Magnetic properties of transition metal compounds. New York, inc. Springer Verlag, 1977.

2. J-P. Launay, M. Verdaguer, Electrons in Molecules, Oxford 2018.
3. A. Abragam, B. Bleaney, Electron Paramagnetic Resonance of Transition Ions, Oxford, 2012.

Course language:
english

Notes:
The course Magnetochemistry is realized in the attendance form. In some special cases (as was pandemics of Covid) the teaching is realized online using software MS Teams, which enables to keep the contact with students and to keep the level and quality of the course.

Course assessment
Total number of assessed students: 2

abs	n
100.0	0.0

Provides: doc. RNDr. Alžbeta Orendáčová, DrSc.

Date of last modification: 27.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ MMTL/04	**Course name:** Modern Methods of Solids Structure Investigation
Course type, scope and the method: **Course type:** Lecture **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 28 **Course method:** present	
Number of ECTS credits: 5	
Recommended semester/trimester of the course: 2.	
Course level: III.	
Prerequisities: ÚFV/MSA1/03	
Conditions for course completion: For successful completing of the subject student have to show after taking exam adequate knowledge from the area using sophisticated research infrastructure for structural analysis of solids. Content of the subject needs previous study of structure analytical methods as TEM, SEM, STEM and X-ray techniques. After pathing the course student is able to design experiment in X-ray laboratory or at large scale facility (LSF) like XFEL and DESY in Hamburg, ESRF Grenoble, JRN Dubna, ILL Grenoble. To be avaluated student have to path though written exam and to defend ppt project or scientific proposal for LSF. To achieve final evaluation, he/she has to work out ppt project dealing with the topic selected on the beginning of the course. Credits evaluation takes into account taking part at the lectures and study of recommended literature -2 credits, 2 credits – project, 1 credit – study for written test. Minimal value to obtain evaluation for other graduates is reach 50% of each evaluation (test and project) points. Point ratio project/test is 60/40. CMP graduates have to reach as minimum 50% points from the project. Participation at Scientific school for XFEL and synchrotron users “SFEL” is also recommended and it can substitute a proposal.	
Learning outcomes: After completing the lectures and after working out the proposal and taking the written test, the student will have a deep knowledge which allow her/him to find relationships between structure and physical properties of metals and also will have the ability to enter into a systematic theoretical and experimental solution of the problems of structural analysis. Student is also able to design experiment in X-ray laboratory or at large scale facility like XFEL and DESY in Hamburg, ESRF Grenoble, JRN Dubna, ILL Grenoble	
Brief outline of the course: Time schedule of the subject content is updated in electronic board in AiS2 sw. The subject content is focused in the following main topics: New trends in Electron microscopy and Electron diffraction. State of art in Electron microprobe analysis: WDX spectrometer, EDX spectrometer, Auger spectroscopy. Modern electron diffracion methods (CBD, nanodiffraction), X-ray diffractometry, phase and profile analysis. Synchrotron radion: sources and application of SR in material science research, neutron scattering , Small angle scattering. Modern methods of surface observation: STM, AFM. Synchrotron radiation in material science research.	

Recommended literature:
1.S. Amelincks, D.van Dyck, J. van Landyut, Electron Microscopy – Principles and Fundamentals, VCH, 1997.
2.M.H. Loretto, Electrom beam analysis of materials. Springer, 2002.
3.Fundamentals of Powder Diffraction and Structural Characterization of Materials, Vitalij K. Pecharsky & Peter Y. Zavalij , Kluwer Academic Publishers, 2003.
4.Structure Determination from Powder Diffraction Data, Edited by W.I.F. David, K. Shankland, L.B. McCusker, C. Bärlocher, Oxford University Press, 2006

Course language:
English

Notes:
Lectures can be done at presence form or online using MS Teams. Education form is updated at the begining of the subject. All ppt presentations are accesible in LMS UPJŠ.

Course assessment
Total number of assessed students: 76

N	P
0.0	100.0

Provides: prof. RNDr. Pavol Sovák, CSc., RNDr. Jozef Bednarčík, PhD., univerzitný docent

Date of last modification: 15.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ MONB/22	**Course name:** Monograph
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week: Per study period:** **Course method:** distance, present	
Number of ECTS credits: 20	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: Co-author of the monograph.	
Learning outcomes: By publishing a monograph, the PhD student demonstrates a high level of ability to identify, evaluate, and apply correct scientific methods or research methodology. It demonstrates the ability to reflect on a scientific problem by using the latest approaches and applying them critically. He demonstrates the competence to use existing theories and concepts in an innovative way, as well as to generate new original scientific knowledge, which he can publish according to the highest qualitative and ethical standards of the field. The doctoral student demonstrates the ability to critically evaluate and respond to reviewers' suggestions, to finalize his own ideas	
Brief outline of the course:	
Recommended literature:	
Course language:	
Notes:	
Course assessment Total number of assessed students: 0	

abs	n
0.0	0.0

Provides:	
Date of last modification: 08.11.2022	
Approved: prof. Ing. Martin Orendáč, DrSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ MONA/22	**Course name:** Monograph in a renowned publishing house
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week: Per study period:** **Course method:** distance, present	
Number of ECTS credits: 40	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: Co-author of a monograph in a renowned publishing house.	
Learning outcomes: By publishing a monograph in a renowned publishing house, the PhD student demonstrates a high level of ability to identify, evaluate, and apply correct scientific methods or research methodology. He demonstrates the ability to reflect on a scientific problem by using the latest approaches and applying them critically. He demonstrates the competence to use existing theories and concepts in an innovative way, as well as to generate new original scientific knowledge, which he can publish according to the highest qualitative and ethical standards of the field. The doctoral student demonstrates the ability to critically evaluate and respond to reviewers' suggestions, to finalize his own ideas.	
Brief outline of the course:	
Recommended literature:	
Course language:	
Notes:	
Course assessment Total number of assessed students: 0	
abs	n
0.0	0.0
Provides:	
Date of last modification: 08.11.2022	
Approved: prof. Ing. Martin Orendáč, DrSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ DK/04	**Course name:** National Conference

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: Per study period:
Course method: distance, present

Number of ECTS credits: 2

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Active participation in the home conference.

Learning outcomes:
By actively participating in the national scientific conference, the PhD student demonstrates a high degree of ability to identify, evaluate, and apply correct scientific methods or research methodology in his scientific field. He demonstrates the ability to reflect on a specific scientific problem by using the latest approaches and applying them critically. Demonstrates competence in using existing theories and concepts in an innovative way, as well as generating new original scientific knowledge and communicating research results to a wider audience using adequate means and through the Slovak language.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 183

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ NRZ/22	**Course name:** Non-Reviewed International or National Proceedings

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: **Per study period:**
Course method: distance, present

Number of ECTS credits: 2

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
A publication published in a non-reviewed foreign or national journal as an author/co-author.

Learning outcomes:
By publishing in a non-reviewed foreign or national journal as an author/co-author, the PhD student demonstrates the ability to identify, evaluate, and apply correct scientific methods or research methodology. He demonstrates the ability to reflect on a scientific problem by using the latest approaches and applying them critically. He demonstrates the competence to use existing theories and concepts in an innovative way, as well as to generate new original scientific knowledge, which he can publish according to the highest qualitative and ethical standards of the field. The phD student demonstrates the ability to finalize his own thoughts in a written speech.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 18

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ OVTL/21	**Course name:** Optical properties of solids

Course type, scope and the method:
Course type: Lecture
Recommended course-load (hours):
Per week: 3 **Per study period:** 42
Course method: present

Number of ECTS credits: 4

Recommended semester/trimester of the course: 4.

Course level: II., III.

Prerequisities:

Conditions for course completion:
To successfully complete the course, the student must demonstrate sufficient knowledge of the optical properties of solids, taking into account the knowledge defined in the course syllabus.
The credit evaluation of the course takes into account the following student workload:
1 credits: direct teaching and self-study of recommended supplementary literature,
3 credits: exam in the form of an oral exam and a test.

Learning outcomes:
Students will gain knowledge in the field of optical properties of solids, with regard to the following knowledge: Optical properties of isotropic materials: Dielectric function of crystals, Symmetry of dielectric tensor, Neumann principle. Optical properties of anisotropic materials: Light propagation in anisotropic media, birefringence, optical activity, inversion center, calculation of counterclockwise and clockwise circularly polarized waves. Crystal symmetry from the perspective of optics. Distribution of crystals according to symmetry and from the point of view of anisotropy. Polarization catastrophe: Difference between local and macroscopic field, Clausio-Mossotti equation. Optical properties of ionic crystals: Susceptibility of ionic crystals, Dielectric function of ionic crystals, Collective modes in ionic crystals, Lyddan-Sachs-Teller (LST) relation, Ferroelectric instability.
Spontaneous and stimulated emission, Quantum theory of light, Luminescence in systems with localized electrons, fluorescence, Franck-Condon effect, luminescence in systems with delocalized electrons. Light scattering and photoemission: Rayleigh scattering, extinction length, critical opalescence, Optical fibers. Raman scattering: Stokes frequency, Selection rules for Raman scattering, Brillouin scattering. Photoemission: principle, presentation of angularly resolved photoemission experiments (ARPES) and their use for characterization of solids. Surface plasmon resonance (SPR) in nanosystems. Experimental methods based on dynamic light scattering. Experimental optical methods for characterization of solids.

Brief outline of the course:
1. Introduction lecture - reminder of terms: Optical constants, Description of the interaction of solids with light (Maxwell's theory, Lorentz-Drude microscopic theory, Semiclassical approach, Quantum description of interaction, Spintronics).

2. Optical properties of isotropic materials: Dielectric function of crystals, Symmetry of dielectric tensor, Optical frequencies, Neumann principle.
3. Optical properties of anisotropic materials: Light propagation in anisotropic media, birefringence, optical activity, inversion center, calculation of counterclockwise and clockwise circularly polarized waves.
4. Symmetry of crystals from the point of view of optics. Distribution of crystals according to symmetry and from the point of view of anisotropy. Polarization catastrophe: Difference between local and macroscopic field, Clausio-Mossotti equation.
5. Optical properties of ionic crystals: Susceptibility of ionic crystals, Dielectric function of ionic crystals, Collective modes in ionic crystals, Lyddan-Sachs-Teller (LST) relation, Ferroelectric instability.
6. Luminescence I: Spontaneous and stimulated emission, Quantum theory of light, Luminescence in systems with localized electrons, fluorescence
7. Luminescence II: Franck-Condon phenomenon, luminescence in systems with delocalized electrons.
8. Light scattering and photoemission: Rayleigh scattering, extinction length, critical opalescence, Optical fibers.
9. Raman scattering: Stokes frequency, Selection rules for Raman scattering, Brillouin scattering.
10 Photoemission: principle, presentation of angularly resolved photoemission experiments (ARPES) and their use for characterization of solids.
11. Surface plasmon resonance (SPR) in nanosystems: principle, practical application and demonstrations of experimental measurements using UV VIS method in the laboratory.
12. Experimental methods based on dynamic light scattering: measurement of nanoparticle size and surface charge (Zetapotential). Principle of the method and demonstrations in the laboratory.
13. Experimental optical methods for characterization of solids: Basics of FT-IR spectroscopy, Basics of Raman spectroscopy, ultrafast photoemission method, time-resolved optical microscopy.
14. Consultations, pre-term of the exam.

Recommended literature:

1. Fox M., Optical Properties of Solids, Oxford, 2001
2. Jan Soubusta, Antonín Černoch, Optical properties of solids, Palacky University, 2014.
3. R. Hlubina, Electrical and optical properties of solids, Komensky University 2018.

Course language:
english

Notes:
Lectures can be done at presence form or online form using MS Teams. Education form is updated at the begining of the subject. All ppt presentations are accesible in LMS UPJŠ.

Course assessment
Total number of assessed students: 6

A	B	C	D	E	FX	N	P
33.33	0.0	0.0	0.0	0.0	0.0	0.0	66.67

Provides: doc. RNDr. Adriana Zeleňáková, PhD.

Date of last modification: 21.11.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: KPE/PgVU/17	**Course name:** Pedagogy for University Teachers

Course type, scope and the method:
Course type: Lecture
Recommended course-load (hours):
Per week: **Per study period:** 28s
Course method: distance, present

Number of ECTS credits: 5

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
1. Development of a teaching diary—100%
2. Compulsory active participation and attendance in accordance with the Study Regulations.

Learning outcomes:
After completing the course, the student will acquire knowledge, skills, and competencies, i.e., will be able to:
Knowledge
Define and apply basic didactic principles, methods, forms, and tools in the teaching process of university-level professional subjects. Identify and specify educational procedures of a university teacher aimed at effective teaching management, pedagogical diagnostics, and assessment of learning outcomes. Recognize different approaches to pedagogical evaluation and their impact on improving the quality of the educational process at the university level.
Skills
Implement effective educational methods and techniques into the teaching of professional subjects, tailored to the needs of university students. Conduct pedagogical diagnostics, assess students' progress, and apply appropriate evaluation methods to improve learning outcomes. Analyze and reflect on one's own teaching process, identify areas for improvement, and enhance the teaching of professional subjects, including the rationalization of the time and content structure of teaching. Present specific proposals for improving the teaching process, including the use of new technologies and innovative pedagogical approaches.
Competencies
Confidently and effectively manage the teaching of university subjects, applying educational competencies that consider the specifics of higher education. Critically reflect on one's own pedagogical practice and the learning outcomes of students to improve teaching methods and achieve a higher quality of the educational process. Apply innovative solutions to streamline and optimize the teaching process, aiming to increase the engagement and success of university students.

Brief outline of the course:
The personality of a university teacher. Teaching styles. Student in university education. Student learning styles. Possibilities of adapting teaching styles and student learning styles. University teacher–student interaction and communication in the teaching process. Pedagogical competencies

of a university teacher. Didactic analysis of the curriculum; teaching materials and textbooks. Forms of university teaching. Methods of university teaching. Verification methods and student assessment. Creation of a didactic test. Designing university teaching process. University teacher self-reflection.

Recommended literature:

Beránek, J. (2023). Moderní pedagogické metody a přístupy. Praha: Portál.
Fiala, M. (2023). Didaktika a metodika v současné škole. Praha: Grada Publishing.
Kováč, M. (2023). Vzdelávanie v 21. storočí: Inovatívne prístupy a metódy. Nitra: Vydavateľstvo UKF v Nitre.
Koudelka, J. (2023). Moderní didaktika a její aplikace. Praha: Karolinum.
Křížová, M., & Šebová, P. (2023). Vzdělávání učitelů: Teoretické a praktické přístupy. Praha: Triton.
Kučerová, M. (2023). Vzdělávání učitelů a profesionální rozvoj. Praha: Triton.
Mocová, M., & Lázňovská, M. (2023). Pedagogika a jej aplikácie v praxi. Bratislava: Vydavateľstvo Spolku slovenských pedagogických pracovníkov.
Novák, J., & Pol, M. (2024). Pedagogické výzkumy a inovace ve vzdělávání. Praha: Portál.
Sikora, J. (2022). Didaktika a metodika vzdelávania: Nové výzvy a trendy. Bratislava: Vydavateľstvo Univerzity Komenského v Bratislave.
Škoda, J. (2022). Efektivní výuka: Praktické strategie a metody. Praha: Grada Publishing.
Švec, J. (2023). Didaktika a školní politika: Teorie a praxe. Praha: Grada Publishing.
Vojtová, K. (2024). Diferenciace a inkluze ve vzdělávání. Praha: Wolters Kluwer.

Course language:
slovak

Notes:

Course assessment
Total number of assessed students: 121

abs	n	neabs
98.35	0.0	1.65

Provides: doc. PaedDr. Renáta Orosová, PhD.

Date of last modification: 14.09.2024

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ FVT/12	**Course name:** Physics of High Pressures

Course type, scope and the method:
Course type: Lecture
Recommended course-load (hours):
Per week: 2 **Per study period:** 28
Course method: present

Number of ECTS credits: 5

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
To successfully complete the course, the student must demonstrate sufficient theoretical knowledge about the effect of pressure on basic physical quantities and phenomena, to show the importance of thermodynamic parameter - pressure in the study of superconducting, magnetic, strongly correlated or structural properties of materials. At the same time, an understanding of all the basic techniques of obtaining high pressure and the implementation of physical experiments in it is required. The student must complete the preparation and course of real measurement at high pressures on a particular device. In addition to direct participation in teaching, the student is obliged to study in the self-study a professional topic close to the assignment of the dissertation, which would also be related to high pressures or their possible use in the study topic. Subsequently, the student is required to develop and present this homework. The credit evaluation of the course takes into account the following student workload: direct teaching and self-study - 2 credits, preparation and implementation of the experiment - 2 credits, independent processing of the assigned topic and its presentation - 1 credit. The minimum limit for obtaining credits is 50 % of each evaluation activity.

Learning outcomes:
After completing lectures and experiment, the student will be sufficiently familiar with the physics and technique of high pressures. The acquired knowledge will broaden his horizons in the field of condensed matter physics and help in the study of current physical problems such as: pressure-induced structural or quantum phase transitions, high-temperature and unconventional superconductivity, topological and frustrated states in quantum systems, pressure tuning of magnetic properties in molecular magnets. At the same time, the student will gain an idea, experience and skills with the preparation and implementation of experiments at high pressures at home and abroad, which may be found in future research.

Brief outline of the course:
Distribution of topics by providers: S. Gabáni - 5., 7., 9.-12.; M. Mihalik - 3., 4., 12.; M. Zentková - 1., 2., 6., 8., 12.
1. Pressure as a basic thermodynamic parameter I.: equations of state, electronic structure of solids under the influence of pressure, Bridgman equations.

2. Pressure as a basic thermodynamic parameter II.: pressure as a parameter in the solid state physics, general mechanisms of action of high pressures on the physical properties of solids, methods of calculation of electronic and crystal structure.
3. Experimental techniques of obtaining high pressures I.: history of pressure experiments, static pressure, pulse pressure experiments, principle of Bridgman cell, liquid and gaseous pressure transmitting medium, piston pressure cells, calibration and measurement of pressure.
4. Measurement of magnetic properties of solids at high pressures. Pressure experiments in SQUID magnetometer, basic mechanisms of pressure influence on magnetic characteristics - Curie temperature, hysteresis loop, influence of pressure on magnetoresistance, influence of pressure on magnetocrystalline anisotropy. Neutron diffraction under pressure, pressure-induced structural phase transitions.
5. Experimental techniques for obtaining high pressures II.: diamond anvil cells for high pressures above 3 GPa, measurement of pressure, heat capacity, electrical resistivity and magnetic susceptibility in these cells.
6. Spectroscopic techniques under pressure: Raman, UV VIS, Moesbauer. Examples of the use of pressure spectroscopic experiments for different types of materials.
7. Nuclear magnetic resonance and point contact spectroscopy under pressure.
8. Pressure tuning of physical properties of molecular magnetic materials. Specifics of the class of molecular magnetic materials, pressure-induced spin crossover transitions.
9. Influence of pressure on superconductivity.
10. Pressure-induced quantum phase transitions in electronic systems. Quantum critical point, "non-Fermi-liquid" behavior, metal-insulator and antiferromagnet-superconductor transitions.
11. Influence of pressure on strongly correlated electron systems. Pressure-induced transition metal-insulator, antiferromagnet-superconductor at temperatures close to absolute zero.
12. Preparation of pressure experiment in piston cells for PPMS and MPMS. Preparation of pressure experiment in diamond anvil cells for PPMS and MPMS. Measurement of magnetic, transport and thermal properties of solids.

Recommended literature:

1. M. I. Eremets: High pressure experimental methods, Oxford University Press, Oxford, (2002)
2. J. Loveday: High pressure physics, CRC Press, Taylor&Francis Group (2012)
3. S. Sachdev: Quantum Phase Transitions, Cambridge University Press, Cambridge (2000)
4. T. Vojta: Quantum phase transitions in electronic systems, Ann. Phys. 9, 403-440 (2000)
5. G. R. Stewart: Non-Fermi-Liquid behavior in d- and f- electron metals, Rev. Mod. Phys. 73, 797-855 (2001)
6. W. Buckel and R. Kleiner: Superconductivity, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim (2004)

Course language:
Slovak, English

Notes:
The course is provided in the presence form, if necessary by distance form using the MS TEAMS environment.

Course assessment
Total number of assessed students: 18

N	P
0.0	100.0

Provides: doc. RNDr. Slavomír Gabáni, PhD., RNDr. Marián Mihálik, CSc., RNDr. Mária Zentková, CSc.
Date of last modification: 23.09.2021
Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/POP/22	**Course name:** Popularisation of science
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week:** **Per study period:** **Course method:** distance, present	
Number of ECTS credits: 5	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: Active involvement in the popularization of science.	
Learning outcomes: Demonstrated ability to present science to the lay public, use interactive methods of scientific communication, identify the target group and adapt the communication language to the level of professional knowledge. A PhD student is able to arouse interest and motivate specific target groups in the field of his scientific work, but also in the wider context of science	
Brief outline of the course:	
Recommended literature:	
Course language:	
Notes:	
Course assessment Total number of assessed students: 66	

abs	n
100.0	0.0

Provides:	
Date of last modification: 08.11.2022	
Approved: prof. Ing. Martin Orendáč, DrSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ UMV/PM/21	**Course name:** Powder functional composite materials
Course type, scope and the method: **Course type:** Lecture **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 28 **Course method:** present	
Number of ECTS credits: 4	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: The student has to demonstrate sufficient knowledge of compacted powder composite materials with emphasis on methods of preparation of micro- and nano-composite powder material systems, structural and physical properties to successfully complete the course. He will gain basic knowledge of methods of coating, homogenization, pressing and heat treatment of powder materials, principles of structure formation, elastic, electrical and magnetic properties, as well as their applications in electrical engineering and electronics. The credit evaluation of the course takes into account the following student workload: 1 credit: self-study of recommended and supplementary literature. 2 credits: elaboration of a presentation on a selected topic resulting from the content of the course, which is related to the topic of the dissertation. 1 credit: independent preparation for the final exam and its successful completion.	
Learning outcomes: The student will demonstrate adequate mastery of the course content as defined by the course syllabus and recommended literature after completing lectures and presentation. The results of education are: 1. Completion and acquisition of knowledge about the relationship between the parameters of compacting technology, structure and functional properties of powder materials. 2. Knowledge of the specifics of methods for characterizing the functional properties of materials. 3. Creation of terminological and knowledge prerequisites for understanding the applicability of physical phenomena in the field of progressive powder composite materials and technologies.	
Brief outline of the course: The content of the course: 1. Powdered metallic, non-metallic, polymeric and hybrid materials with specific physical properties - basic concepts. 2. Electrical, magnetic, thermal, elastic strength properties of composite materials. 3. Structural properties of functional composite materials. 4. Methods of preparation of powder materials - mechanical alloying, mechanochemical synthesis, coating of powder particles, homogenization of composite powders. 5. Methods of compacting powder composite materials - pressing, sintering, powder injection, isostatic pressing, hot pressing, sintering with the assistance of electric and magnetic fields, laser and electron beam sintering, additive	

production, 3D printing. 6. Characterization of powder composites and methods for measuring functional properties. 7. Progressive compacted powder composite materials and their applications - ferromagnetic, ferrimagnetic materials, soft magnetic composites, sintered hard magnetic materials, multifunctional materials for electronics, smart composites.

Recommended literature:

1. Šalak A.: Ferrous Powder Metallurgy, Cambridge International Science Publishing, 1997
2. B. D. Cullity, C. D. Graham: Introduction to Magnetic Materials, 2nd edition, IEEE Press, Wiley, 2009, ISBN:9780470386323. https://doi.org/10.1002/9780470386323
3. Isaac Chang and Yuyuan Zhao: Advances in Powder Metallurgy - properties, processing and applications, Woodhead Publishing Limited, 2013, ISBN: 9780857098900. https://doi.org/10.1016/B978-0-12-819726-4.00151-4
4. L.J. Huang, L. Geng, H-X. Peng: Microstructurally inhomogeneous composites: Is a homogeneous reinforcement distribution optimal?, Progress in Materials Science, 71 (2015), 93–168

Course language:
english

Notes:
Teaching is carried out full-time or part-time using the MS Teams tool. The form of teaching is specified by the teacher at the beginning of the semester and it is continuously updated.

Course assessment
Total number of assessed students: 2

N	P
0.0	100.0

Provides: Ing. Radovan Bureš, CSc., doc. RNDr. Ján Füzer, PhD.

Date of last modification: 28.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ VYS/22	**Course name:** Presentation in Seminar

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: **Per study period:**
Course method: distance, present

Number of ECTS credits: 5

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Presentation at the seminar

Learning outcomes:
By actively participating in the seminar, the PhD student demonstrates the ability to identify, evaluate, and apply correct scientific methods or research methodology in his field of study. He demonstrates the ability to reflect on a specific scientific problem by using the latest approaches and applying them critically. Demonstrates competence in using existing theories and concepts in an innovative way, as well as generating new original scientific knowledge and communicating research results by adequate means and through Slovak or a foreign language.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 39

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ ZRIG/22	**Course name:** Principal investigator of an internal grant (VVGS)

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: Per study period:
Course method: distance, present

Number of ECTS credits: 10

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Principal investigator of an internal grant (VVGS)

Learning outcomes:
The PhD student demonstrates the ability to process a successful application for his own research problem within the internal grant system at UPJŠ. Acquires skills with the design of research stages, their time schedule, measurable outputs and adequate distribution of funds. The very solution of the internal VVGS grant acquires the ability to implement the project intention according to the established procedure, to be responsible for achieving the set outputs. As a responsible researcher, the PhD student acquires competencies in project management, its administration, and presentation of results.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 20

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ NSM/12	**Course name:** Processing, properties and applications of nanomaterials

Course type, scope and the method:
Course type: Lecture
Recommended course-load (hours):
Per week: 2 **Per study period:** 28
Course method: present

Number of ECTS credits: 5

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
To successfully complete the course, the student must demonstrate sufficient understanding of the basic concept in field of nanomaterials and their applications. For obtaining credits student must pass midterm written exam about basic concepts in field of nanomaterials. More advanced topics will be part of final oral exam. The credit evaluation of the course takes into account the following student workload: direct teaching 2 credits, self-study 1 credit, study for interim test and final test 2 credits. The minimum threshold for completing the course is to obtain at least 50% of the total score, using the following rating scale: A (90-100%), B (80-89%), C (70-79%), D (60- 69%), E (50-59%), F (0-49%).

Learning outcomes:
The aim of the course is to acquaint students with the preparation and properties of nanomaterials. Based on the discussed specific applications, the student will understand their unique properties and behavior.

Brief outline of the course:
Thematic areas:
1. Preparation of nanomaterials using lithographic methods.
Shaping of nanostructures. Optical lithography, electron beam lithography,
wet chemical etching, dry etching, focusing electron beam shaping, lithography using scanning probe microscopy.
2. Preparation and properties of thin films and multilayers.
Thin film preparation technologies. Steaming, sputtering, so-called atomic layer deposition,
epitaxial growth technology, nucleation and growth, planar systems, lateral structured systems, anisotropy in thin films, domain wall in thin films. Magnetic multilayers, GMR effect.
3. Preparation of nanocrystalline metals, alloys and composites by electrodeposition
Synthesis of nanostructured composite materials by electrodeposition, structure of nanocrystalline metal electrodeposited layers, properties and applications
4. Data recording and storage using nanotechnologies
The current state of commercial data storage devices, the possibilities offered by nanotechnologies, data recording using the so-called millipede concept, race track memories, gmr effect devices, so called phase change memory

5. Nanoelectronics, optoelectronics and nanorobotics.
Single electron transistor concept, manufacturing and physical porinciple. Single atom transistor: concept, production and physical principle. Optoelectronic devices and advances in nanorobotics.
6. Diffusion in NKM: Modeling of interface diffusion, diffusion in grain boundaries. Diffusion in nanocrystalline metals: specific aspects, nanocrystalline pure metals, relationship between diffusion and grain growth, selected examples of diffusion (magnetically soft and hard NKM,), hydrogen diffusion in NKM
7. Magnetic nanoparticles and their applications: Physics of magnetic nanoparticles: bulk ferromagnetism, magnetic clusters, molecular magnetism, ideal monodomain particle, surface effects and interfacial effects, exchange interaction between nanoparticles. Applications of monodomain magnets: Ferrofluids, biomedical applications, magnetic nanoparticle imaging, data storage media, magnetoresistive devices.
8. Magnetic properties of selected nanosystems: amorphous Fe-MB alloys (amorphous and nanocrystalline state, induced anisotropy), FINEMET, Influence of substitutions on properties of Finemet alloys, Fe-Zr-Nb-B alloys, Fe-Nb-BP-Cu produced in the atmosphere , the effect of grain size distribution on Tc and amorphous residue.
9. Mechanical behavior of NKM: Models and simulation of mechanical properties of NKM, models of deformation, density, pores and microcracks, elastic properties, hardness, tensile strength, ductility, examples of experimental results.

Recommended literature:
1. C.C. Koch, Nanostructured Materials – processing, Properties and Applications, WA Publishing, 2007.
2.Springer Hanbook of Nanotechnology, B. Bhusnan (Ed.), Springer 2007.
3. Nanomagnetism and Spintronics, T. Shinjo (Ed.) Elsevier 2009.
4. P.Sovák, A. Zorkovská, Structure and Magnetic Properties of FINEMET based Alloys, UPJŠ, 2008, ISBN 978-80-7097-719-4.

Course language:
slovak and english

Notes:
Teaching is carried out full-time or part-time using the MS teams platform. Form of teaching are specified by the teacher at the beginning of the semester and continuously updated as needed.

Course assessment
Total number of assessed students: 32

N	P
0.0	100.0

Provides: doc. Mgr. Vladimír Komanický, Ph.D.

Date of last modification: 27.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: KPPaPZ/PsVU/17	**Course name:** Psychology for University Lecturers

Course type, scope and the method:
Course type: Lecture
Recommended course-load (hours):
Per week: **Per study period:** 28s
Course method: distance, present

Number of ECTS credits: 5

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Case study, micro-output, its analysis
Current modifications of the course are listed in the electronic bulletin board of the course.

Learning outcomes:
After completing the course, students will gain knowledge that allows them to understand, summarize and explain selected psychological knowledge from cognitive psychology, emotion and motivation psychology, personality psychology, developmental, social, educational psychology and health psychology. They will acquire skills to apply the above psychological knowledge necessary for the professional, competent performance of university teaching practice of doctoral students to create and implement the teaching of a professional topic with applied psychological knowledge and develop the competences to create and implement teaching of a professional topic with the application of psychological knowledge, as well as to evaluate their performance and the performance of their classmates in the form of constructive feedback.

Brief outline of the course:
The content of the course is based on selected psychological knowledge of cognitive psychology, psychology of emotions and motivation, personality psychology, developmental, social, educational psychology and health psychology. Teaching is realized by a combination of lectures with interactive, experiential methods, discussion, open communication with mutual respect, support of independence, activity and motivation of students. Syllabus: University teacher and his work in the teaching process with a focus on: teachers in relation to themselves (cognitive, personal, social and competencies in the use of methods), in relation to students and as part of the teacher-student relationship on the basis of selected areas of cognitive psychology, psychology of emotions and motivation, developmental psychology, social psychology, educational psychology and health psychology with application to the university environment

Recommended literature:
Alexitch, L. R. (2005). Applying social psychology to education. Social Psychology.–Ed.: Schneider F., Gruman J., Coutts L.–Sage Publications, Inc, 205-228.
Fry, H., Ketteridge, S., & Marshall, S. (2008). A handbook for teaching and learning in higher education: Enhancing academic practice. Routledge.
Mareš, J.: Pedagogická psychologie. Portál, 2013.

Kniha psychologie. Universum, 2014
Čáp, J., Mareš, J.: Psychologie pro učitele. Praha: Portál 2007.
Vágnerová, M.: Školní poradenská psycholópie pro pedagogy. Praha: Karolínum 2005.

Course language:
slovak

Notes:

Course assessment
Total number of assessed students: 87

abs	n	neabs
98.85	0.0	1.15

Provides: PhDr. Anna Janovská, PhD.

Date of last modification: 02.12.2024

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ Q1SA/22	**Course name:** Q1 journal as co-author

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: **Per study period:**
Course method: distance, present

Number of ECTS credits: 30

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Publication accepted in a journal of category Q1 as co-author.

Learning outcomes:
By publishing in a journal of category Q1 as a co-author, the PhD student demonstrates a high degree of ability to identify, evaluate, and apply correct scientific methods or research methodology. He demonstrates the ability to reflect on a scientific problem by using the latest approaches and applying them critically. He demonstrates the competence to use existing theories and concepts in an innovative way, as well as to generate new original scientific knowledge, which he can publish according to the highest qualitative and ethical standards of the field. The PhD student demonstrates the ability to critically evaluate and respond to reviewers' suggestions, to finalize his own ideas

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 24

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ Q11A/22	**Course name:** Q1 journal as first or corresponding author
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week: Per study period:** **Course method:** distance, present	
Number of ECTS credits: 40	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: Publication accepted in a journal of category Q1 as first or corresponding author	
Learning outcomes: By publishing in a journal of category Q1 as the first or corresponding author, the PhD student demonstrates a high degree of ability to identify, evaluate, and apply correct scientific methods or research methodology. He demonstrates the ability to reflect on a scientific problem by using the latest approaches and applying them critically. He demonstrates the competence to use existing theories and concepts in an innovative way, as well as to generate new original scientific knowledge, which he can publish according to the highest qualitative and ethical standards of the field. The PhD student demonstrates the ability to critically evaluate and respond to reviewers' suggestions, to finalize his own ideas.	
Brief outline of the course:	
Recommended literature:	
Course language:	
Notes:	
Course assessment Total number of assessed students: 12	

abs	n
100.0	0.0

Provides:	
Date of last modification: 08.11.2022	
Approved: prof. Ing. Martin Orendáč, DrSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/Q2SA/22	**Course name:** Q2 journal as co-author

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: Per study period:
Course method: distance, present

Number of ECTS credits: 20

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Publication accepted in a journal of category Q2 as co-author.

Learning outcomes:
By publishing in a journal of category Q2 as a co-author, the PhD student demonstrates a high degree of ability to identify, evaluate, and apply correct scientific methods or research methodology. He demonstrates the ability to reflect on a scientific problem by using the latest approaches and applying them critically. He demonstrates the competence to use existing theories and concepts in an innovative way, as well as to generate new original scientific knowledge, which he can publish according to the highest qualitative and ethical standards of the field. The PhD student demonstrates the ability to critically evaluate and respond to reviewers' suggestions, to finalize his own ideas.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 21

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ Q21A/22	**Course name:** Q2 journal as first or corresponding author
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week: Per study period:** **Course method:** distance, present	
Number of ECTS credits: 30	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: Publication accepted in a journal of category Q2 as first or corresponding author.	
Learning outcomes: By publishing in a journal of category Q2 as the first or corresponding author, the PhD student demonstrates a high degree of ability to identify, evaluate, and apply correct scientific methods or research methodology. He demonstrates the ability to reflect on a scientific problem by using the latest approaches and applying them critically. He demonstrates the competence to use existing theories and concepts in an innovative way, as well as to generate new original scientific knowledge, which he can publish according to the highest qualitative and ethical standards of the field. The PhD student demonstrates the ability to critically evaluate and respond to reviewers' suggestions, to finalize his own ideas.	
Brief outline of the course:	
Recommended literature:	
Course language:	
Notes:	
Course assessment Total number of assessed students: 15	
abs	n
100.0	0.0
Provides:	
Date of last modification: 08.11.2022	
Approved: prof. Ing. Martin Orendáč, DrSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ Q3SA/22	**Course name:** Q3 journal as co-author

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: **Per study period:**
Course method: distance, present

Number of ECTS credits: 15

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Publication accepted in a journal of category Q3 as co-author.

Learning outcomes:
By publishing in a journal of category Q3 as a co-author, the PhD student demonstrates a high degree of ability to identify, evaluate, and apply correct scientific methods or research methodology. He demonstrates the ability to reflect on a scientific problem by using the latest approaches and applying them critically. He demonstrates the competence to use existing theories and concepts in an innovative way, as well as to generate new original scientific knowledge, which he can publish according to the highest qualitative and ethical standards of the field. The PhD student demonstrates the ability to critically evaluate and respond to reviewers' suggestions, to finalize his own ideas.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 6

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ Q31A/22	**Course name:** Q3 journal as first or corresponding author

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: **Per study period:**
Course method: distance, present

Number of ECTS credits: 25

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Publication accepted in a journal of category Q3 as first or corresponding author

Learning outcomes:
By publishing in a journal of category Q3 as the first or corresponding author, the PhD student demonstrates a high degree of ability to identify, evaluate, and apply correct scientific methods or research methodology. He demonstrates the ability to reflect on a scientific problem by using the latest approaches and applying them critically. He demonstrates the competence to use existing theories and concepts in an innovative way, as well as to generate new original scientific knowledge, which he can publish according to the highest qualitative and ethical standards of the field. The PhD student demonstrates the ability to critically evaluate and respond to reviewers' suggestions, to finalize his own ideas

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 2

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ Q4SA/22	**Course name:** Q4 journal as co-author

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: Per study period:
Course method: distance, present

Number of ECTS credits: 10

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Publication accepted in a journal of category Q4 as co-author.

Learning outcomes:
By publishing in a journal of category Q4 as a co-author, the PhD student demonstrates a high degree of ability to identify, evaluate, and apply correct scientific methods or research methodology. He demonstrates the ability to reflect on a scientific problem by using the latest approaches and applying them critically. He demonstrates the competence to use existing theories and concepts in an innovative way, as well as to generate new original scientific knowledge, which he can publish according to the highest qualitative and ethical standards of the field. The PhD student demonstrates the ability to critically evaluate and respond to reviewers' suggestions, to finalize his own ideas.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 6

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ Q41A/22	**Course name:** Q4 journal as first or corresponding author

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: Per study period:
Course method: distance, present

Number of ECTS credits: 20

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Publication accepted in a journal of category Q4 as first or corresponding author.

Learning outcomes:

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 2

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ KTM/14	**Course name:** Quantum Theory of Magnetism

Course type, scope and the method:
Course type: Lecture
Recommended course-load (hours):
Per week: 3 **Per study period:** 42
Course method: present

Number of ECTS credits: 5

Recommended semester/trimester of the course:

Course level: II., III.

Prerequisities:

Conditions for course completion:
To successfully complete the course, the student must demonstrate sufficient understanding of the basics terms, concepts, and applications of quantum theory of magnetism. Knowledge of basic concepts of quantum physics at the level of their mathematical definition is required, as well as understanding of their physical content and specific applications in the field of magnetism. During the semester, the student must continuously master the content of the curriculum, so that he can actively and creatively use the acquired knowledge in solving specific tasks assigned to independent solutions at home. The condition for obtaining credits is passing an oral exam, which consists of one more demanding computational task and theoretical questions covering the entire scope of the course. The credit evaluation of the course takes into account the following student workload: direct teaching (2 credits), self-study (1 credit), individual consultations (1 credit) and assessment (1 credit). The minimum threshold for completing the course is to obtain at least 50% of the total score, using the following rating scale: A (90-100%), B (80-89%), C (70-79%), D (60- 69%), E (50-59%), F (0-49%).

Learning outcomes:
After completing lectures, the student will have sufficient physical skills, knowledge and mathematical apparatus enabling independent solution of a wide range traditional and current scientific problems in quantum theory of magnetism. At the same time, he will gain an overview of the applications of quantum theory of magnetism for a description of insulating magnetic materials.

Brief outline of the course:
1. Introduction to quantum theory of magnetism, definition of basic lattice-statistical models in magnetism: Ising model, Heisenberg model, Hubbard model, t-J model.
2. Exchange interaction and its quantum-mechanical origin. Formalism of the second quantization and basic commutation relations between ladder spin operators.
3. Elementary quantum theory of a pair of interacting magnetic particles: Heisenberg dimer.
4. Elementary quantum theory of a pair of interacting magnetic particles: Hubbard dimer.
5. One-dimensional quantum Heisenberg model, spin waves as collective excitations of ferromagnetic spin chain, one-magnon spectrum.

6. One-dimensional quantum Heisenberg model with ferromagnetic interaction, two-magnon spectrum, free and bound spin waves, basics of Bethe-ansatz method.
7. Crystal of singlet dimers as a basic state of frustrated quantum Heisenberg models (Majumdar-Ghosh model and Gelfand ladder).
8. Fermionization of one-dimensional quantum XX model in transverse magnetic field: Jordan-Wigner and Fourier transform. Quantum critical point and thermodynamic behavior.
9. Fermionization of one-dimensional quantum Ising model in transverse magnetic field: Jordan-Wigner, Fourier and Bogoliubov transformation.
10. Variational description of quantum phase transitions in dimerized quantum Heisenberg spin models.
11. Theory of localized magnons as a tool for a simple description of the thermodynamic behavior of frustrated quantum Heisenberg models at nonzero temperatures.
12. Spin-wave theory for a generalized quantum Heisenberg model of arbitrary spatial dimension and spin size. Bosonization through the Holstein-Primakoff transformation.

Recommended literature:
1. J. B. Parkinson, D. J. J. Farnell, An Introduction to Quantum Spin Systems, Lecture Notes in Physics 816 (Springer, Berlin Heidelberg, 2010).
2. U. Schollwock, J. Richter, D. J. J. Farnell, R. F. Bishop, Quantum Magnetism, Lecture Notes in Physics 645 (Springer, Berlin Heidelberg, 2004).
3. N. Majlis, The Quantum Theory of Magnetism (World Scientific, Singapore, 2000).

Course language:
EN - english

Notes:
The subject is realized in presence form, in case of need in distance form in MS Teams enviroment.

Course assessment
Total number of assessed students: 31

A	B	C	D	E	FX	N	P
12.9	32.26	12.9	3.23	12.9	3.23	6.45	16.13

Provides: doc. RNDr. Jozef Strečka, PhD.

Date of last modification: 19.11.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/RZ/22	**Course name:** Reviewed International or National Proceedings

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: **Per study period:**
Course method: distance, present

Number of ECTS credits: 5

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
A publication published in a peer-reviewed foreign or national proceedings as an author/co-author.

Learning outcomes:
By publishing in a peer-reviewed foreign or national journal as an author/co-author, the PhD student demonstrates a high degree of ability to identify, evaluate, and apply correct scientific methods or research methodology. He demonstrates the ability to reflect on a scientific problem by using the latest approaches and applying them critically. He demonstrates the competence to use existing theories and concepts in an innovative way, as well as to generate new original scientific knowledge, which he can publish according to the highest qualitative and ethical standards of the field. The PhD student demonstrates the ability to critically evaluate and respond to reviewers' suggestions, to finalize his own ideas.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 72

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ RSM/12	**Course name:** Scanning probe microscopy
Course type, scope and the method: **Course type:** Lecture **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 28 **Course method:** present	
Number of ECTS credits: 3	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: To successfully complete the course, the student must demonstrate sufficient understanding of the basic physical principles and technical details of state-of-the-art experimental methods based on scanning probe microscopy used in Condensed Matter Physics and nanotechnology. To obtain credits, students are required to prepare a presentation about one of the described experimental methods, or its application and pass an oral examination. The credit evaluation of the course considers the following student workload: direct teaching (1 credit), self-learning and presentation preparation (1 credit), assessment (1 credit). The minimum threshold for completing the course is to obtain at least 50% of the total score, using the following rating scale: A (90-100%), B (80-89%), C (70-79%), D (60- 69%), E (50-59%), F (0-49%).	
Learning outcomes: The course provides a basic overview of the principles and state of the art methods based on scanning probe microscopy.	
Brief outline of the course: Principles of scanning probe microscopies (STM, AFM, MFM etc.), tunneling and point contact spectroscopy of metals and superconductors, experiments in vacuum and at low temperatures, preparation of crystal surfaces, monolayers and thin films. 1. Introduction – From optical microscope to scanning tunneling microscope Optical microscopy, electron microscopy, scanning tunneling microscopy 2. Quantum tunneling History, theory, tunneling current and conductivity, tunneling current vs. barrier, effect of temperature and magnetic field 3. Scanning tunneling microscopy (STM) Piezoelectric effect in STM, methods of approaching the STM tip to the surface of the sample, controller electronics, scanning modes, principles of the PID feedback loop, topography imaging, numerical methods of data analysis. 4. Tunneling spectroscopy (TS) Principles of tunneling spectroscopy, tunneling through planar and vacuum barrier, electronic structure of metals, semiconductors and superconductors; Current vs. voltage and differential conductance vs. voltage characteristics, controller electronics, conductance imaging tunneling	

spectroscopy (CITS), numerical methods of data analysis; TS of metals, semiconductors, molecules and various nanostructures
5. Tunneling spectroscopy of superconductors
NIS and SIS tunneling contacts, superconducting energy gap, effect of temperature and magnetic field, superconducting vortices, vortex pinning and dynamics
6. Point contact spectroscopy (PCS)
Elastic and non-elastic PCS of metals and superconductors; types of point contacts: thin films, needle – anvil, edge – to – edge, lithography, break junctions; effect of temperature and magnetic field
7. Experimental methods
Mechanical design; Low temperatures equipment: historical overview, helium liquefaction, cooling methods, refrigerator types, low temperature technologies; vacuum equipment: pumping, pressure gauges, vacuum technologies; sample preparation: surface cleaning, preparation of thin films and nanostructures by evaporation, sputtering etc.
8. Visit of low temperature STM laboratory, experiment preparation and realization
9. Scanning probe microscopies (SPM)
History, principles of atomic force microscope (AFM), scanning modes, detection of the probe - sample interaction; some other types of SPM: magnetic force microscopy, Kelvin probe microscopy, scanning Hall probe microscopy,
10. STM modifications
Spin polarized STM, electrochemical STM, Fourier transformation STM, Josephson STM etc.
11. Nanomanipulation, Lithography by SPM
Dip pen, local anodic oxidation, nanoscratching, nanoindentation, atomic manipulation etc.
12. Visit of SPM and nanotechnology laboratory, experiment preparation and realization

Recommended literature:

Roland Wiesendanger: Scanning Probe Microscopy and Spectroscopy: Methods and Applications, Cambridge University Press 1994
Yu.G. Naidyuk, I.K. Yanson: Point contact spectroscopy, Springer, 2003
E.L. Wolf: Principles of electron tunneling spectroscopy, Oxford university press, 1989
K. Oura, V.G. Lifshits, A.A. Saranin, A.V. Zotov, M. Katayama: Surface Science: An Introduction, Springer, Berlín 2003

Course language:
Slovak, English

Notes:
The course comprises onsite lectures. If necessary, online lectures will be provided via MS Teams.

Course assessment
Total number of assessed students: 18

N	P
0.0	100.0

Provides: Mgr. Tomáš Samuely, PhD., univerzitný docent

Date of last modification: 27.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ VPZ/22	**Course name:** Scientific work after sending to the editorial office

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: Per study period:
Course method: distance, present

Number of ECTS credits: 5

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Scientific work after being sent to the editorial office as an author/co-author.

Learning outcomes:
By sending a manuscript to the editors of a scientific journal as an author/co-author, the PhD student demonstrates a high degree of ability to identify, evaluate, and apply correct scientific methods or research methodology. He demonstrates the ability to reflect on a scientific problem by using the latest approaches and applying them critically. He demonstrates the competence to use existing theories and concepts in an innovative way, as well as to generate new original scientific knowledge, which he can publish according to the highest qualitative and ethical standards of the field. The PhD student demonstrates the ability to formulate his own ideas in a structured form.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 20

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/VPM/18	**Course name:** Selected problems of numerical methods in micromagnetism

Course type, scope and the method:
Course type: Lecture
Recommended course-load (hours):
Per week: 1 **Per study period:** 14
Course method: present

Number of ECTS credits: 2

Recommended semester/trimester of the course: 2., 4.

Course level: II., III.

Prerequisities:

Conditions for course completion:
To successfully complete the course, the student must understand the basics of micromagnetic simulations. They must know the basic functions of the OOMMF simulation environment and create simple scripts, as well as process the outputs of these simulations. The final assessment is given on an oral exam.
Final assessment takes into account the scope of teaching (2 credits), consultations and assessment (1 credit).
Grading scale: A - 91%-100% points, B - 81%-90% points, C - 71%-80% points ,D - 61%-70% points, E - 51%-60% points.

Learning outcomes:
After completing the lectures, the student will have knowledge of creating micromagnetic simulations of simple systems. It will be able to run these simulations using scripting, thus automating the process.

Brief outline of the course:
1. Introduction to micromagnetic simulations. Equation of motion of a magnetic moment in external magnetic field. Effective field. Gibbs free energy. Langevin dynamics. Characteristic length of scaling. Numeric methods in micromagnetism. Discretization, final elements. Calculation of a magnetostatic fields. Time integration.
2. Simulation software OOMMF. OOMMF architecture overview. Scripting by command line. Scripting using Python. Parallelization of solution. Input/output parameters of scripting.
3. OOMMF solver – description of a child classes Atlases, Meshes, Energies, Evolvers, Drivers and Field objects.
4. Output of simulations, description of tools mmDataTable, mmDataGraph, mmDisp and mmArchive.
5. Conversion of outputs, conversion of three-dimensional vector fields into bmp, postscript and data tables. Description of *.mif format. Material parameters, initial magnetization, demagnetization fields, parameters of simulations, stop criteria of simulations.
6. Simulation of a domain wall in thin magnetic wire. Compensation of a stray fields produced by free ends of a wire. Various initial spin structures of a domain wall.

7. Simulation of hysteresis loops of nanowires, Circular discs. Implementation of temperature in a micromagnetic solver.

Recommended literature:

1. A. Friedman, Micromagnetic simulation v: Mathematics in Industrial Problems. The IMA Volumes in Mathematics and its Applications, vol 57. Springer, New York, NY
2. S. Chikazumi, Physics of Ferromagnetism, Oxford University Press, USA (2009)
3. A. Prohl, Computational Micromagnetism v: Advances in Numerical Mathematics, ISSN 1616-2994, Springer, New York, NY

Course language:
Slovak, English

Notes:
The course is realized via on-site lectures, if necessary, online via MS Teams.

Course assessment
Total number of assessed students: 0

A	B	C	D	E	FX	N	P
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Provides: RNDr. Kornel Richter, PhD.

Date of last modification: 28.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ SFKL1a/22	**Course name:** Seminar in Condensed Matter Physics

Course type, scope and the method:
Course type: Practice
Recommended course-load (hours):
Per week: 1 **Per study period:** 14
Course method: present

Number of ECTS credits: 2

Recommended semester/trimester of the course: 1.

Course level: III.

Prerequisities:

Conditions for course completion:
Successful completing the course requires the students to participate in the seminars. If serious reasons (disease, family reasons, …) prevent the student to participate in the seminar, students may absent up to twice per semester without further consequences. For more frequent absence student will prepare presentation focused on a topic which will be consulted with the supervisor of the seminar. Student must have adequate knowledge about concepts, phenomena and laws discussed in the presented talks. Preparing a presentation is compulsory, the presentation is devoted to the discussion of scientific goals of the dissertation thesis. The student is encouraged to refer to the talks presented in the seminar. The number of credits takes into account participation of the student on the seminar, study of the recommended literature and preparation of the presentation. The level of the presentation is evaluated using the scale from 0 to 100 points. The minimum limit for successful completion of the course is to obtain 50 points from the subsequent point evaluation:
Rating scale
A 100-91
B 90-81
C 80-71
D 70-61
E 60-50
Fx 49-0

Learning outcomes:
Successful completing the course deepens knowledge of the student from the area in which student works on the dissertation thesis and from other areas of Condensed Matter Physics as well. Student will learn about scientific results of various research group from Košice and from their cooperating foreign institutions. The student is stimulated to participate in scientific discussion and to present own scientific results.

Brief outline of the course:
The program of seminars from condensed matter physics is prepared every year and is devoted to the recent results achieved in the field of condensed matter physics and material research at the laboratories in Košice and abroad. Scientific workers from laboratories from Košice as well

as domestic and foreign guests give the talks. The program also involves presentation of PhD and diploma theses.

Recommended literature:
Scientific papers, which are specified according to the scope of work of a student.

Course language:
Slovak, English

Notes:
Presence form represents a standard form for the course, if a need arises, the course is performed using MS Teams.

Course assessment
Total number of assessed students: 8

abs	n
100.0	0.0

Provides: prof. Ing. Martin Orendáč, DrSc.

Date of last modification: 18.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ SFKL1b/22	**Course name:** Seminar in Condensed Matter Physics

Course type, scope and the method:
Course type: Practice
Recommended course-load (hours):
Per week: 1 **Per study period:** 14
Course method: present

Number of ECTS credits: 2

Recommended semester/trimester of the course: 2.

Course level: III.

Prerequisities:

Conditions for course completion:
Successful completing the course requires the students to participate on the seminars. If serious reasons (disease, family reasons, …) prevent the student to participate in the seminar, students may absent up to twice per semester without further consequences. For more frequent absence student will prepare presentation focused on a topic which will be consulted with the supervisor of the seminar. Student must have adequate knowledge about concepts, phenomena and laws discussed in the presented talks. Preparing a presentation is compulsory, the presentation is devoted to the discussion of experimental techniques which will be adopted during the work on the dissertation thesis. The student is encouraged to refer to the talks presented in the seminar. The number of credits takes into account participation of the student on the seminar, study of the recommended literature and preparation of the presentation. The level of the presentation is evaluated using the scale from 0 to 100 points. The minimum limit for successful completion of the course is to obtain 50 points from the subsequent point evaluation:
Rating scale
A 100-91
B 90-81
C 80-71
D 70-61
E 60-50
Fx 49-0

Learning outcomes:
Successful completing the course deepens knowledge of the student from the area in which student works on the dissertation thesis and from other areas of Condensed Matter Physics as well. Student will learn about scientific results of various research group from Košice and from their cooperating foreign institutions. The student is stimulated to participate in scientific discussion and to present own scientific results.

Brief outline of the course:
The program of seminars from condensed matter physics is prepared every year and is devoted to the recent results achieved in the field of condensed matter physics and material research at the laboratories in Košice and abroad. Scientific workers from laboratories from Košice as well

as domestic and foreign guests give the talks. The program also involves presentation of PhD and diploma theses.

Recommended literature:
Scientific papers, which are specified according to the scope of work of a student.

Course language:
Slovak, English

Notes:
Presence form represents a standard form for the course, if a need arises, the course is performed using MS Teams.

Course assessment
Total number of assessed students: 8

abs	n
100.0	0.0

Provides: prof. Ing. Martin Orendáč, DrSc.

Date of last modification: 18.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ SFKL2a/22	**Course name:** Seminar in Condensed Matter Physics

Course type, scope and the method:
Course type: Practice
Recommended course-load (hours):
Per week: 1 **Per study period:** 14
Course method: present

Number of ECTS credits: 2

Recommended semester/trimester of the course: 3.

Course level: III.

Prerequisities:

Conditions for course completion:
Successful completing the course requires the students to participate in the seminars. If serious reasons (disease, family reasons, …) prevent the student to participate in the seminar, students may absent up to twice per semester without further consequences. For more frequent absence student will prepare presentation focused on a topic which will be consulted with the supervisor of the seminar. Student must have adequate knowledge about concepts, phenomena and laws discussed in the presented talks. Preparing a presentation is compulsory, the presentation is devoted to three selected papers of other authors working in the same field.
The student is encouraged to refer to the talks presented in the seminar. The number of credits takes into account participation of the student on the seminar, study of the recommended literature and preparation of the presentation. The level of the presentation is evaluated using the scale from 0 to 100 points. The minimum limit for successful completion of the course is to obtain 50 points from the subsequent point evaluation:
Rating scale
A 100-91
B 90-81
C 80-71
D 70-61
E 60-50
Fx 49-0

Learning outcomes:
Successful completing the course deepens knowledge of the student from the area in which student works on the dissertation thesis and from other areas of Condensed Matter Physics as well. Student will learn about scientific results of various research group from Košice and from their cooperating foreign institutions. The student is stimulated to participate in scientific discussion and to present own scientific results.

Brief outline of the course:
The program of seminars from condensed matter physics is prepared every year and is devoted to the recent results achieved in the field of condensed matter physics and material research at the laboratories in Košice and abroad. Scientific workers from laboratories from Košice as well

as domestic and foreign guests give the talks. The program also involves presentation of PhD and diploma theses.

Recommended literature:
Scientific papers, which are specified according to the scope of work of a student.

Course language:
Slovak, English

Notes:
Presence form represents a standard form for the course, if a need arises, the course is performed using MS Teams.

Course assessment
Total number of assessed students: 12

abs	n
100.0	0.0

Provides: prof. Ing. Martin Orendáč, DrSc.

Date of last modification: 18.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/SFKL2b/22	**Course name:** Seminar in Condensed Matter Physics

Course type, scope and the method:
Course type: Practice
Recommended course-load (hours):
Per week: 1 **Per study period:** 14
Course method: present

Number of ECTS credits: 2

Recommended semester/trimester of the course: 4.

Course level: III.

Prerequisities:

Conditions for course completion:
Successful completing the course requires the students to participate in the seminars. If serious reasons (disease, family reasons, …) prevent the student to participate in the seminar, students may absent up to twice per semester without further consequences. For more frequent absence student will prepare presentation focused on a topic which will be consulted with the supervisor of the seminar. Student must have adequate knowledge about concepts, phenomena and laws discussed in the presented talks. Preparing a presentation is compulsory, the presentation is devoted to the results obtained during work on dissertation thesis which have been, or will be published. Alternatively, the presentation may address potential practical applications of the studied materials. The student is encouraged to refer to the talks presented in the seminar. The number of credits takes into account participation of the student on the seminar, study of the recommended literature and preparation of the presentation. The level of the presentation is evaluated using the scale from 0 to 100 points. The minimum limit for successful completion of the course is to obtain 50 points from the subsequent point evaluation:
Rating scale
A 100-91
B 90-81
C 80-71
D 70-61
E 60-50
Fx 49-0

Learning outcomes:
Successful completing the course deepens knowledge of the student from the area in which student works on the dissertation thesis and from other areas of Condensed Matter Physics as well. Student will learn about scientific results of various research group from Košice and from their cooperating foreign institutions. The student is stimulated to participate in scientific discussion and to present own scientific results.

Brief outline of the course:
The program of seminars from condensed matter physics is prepared every year and is devoted to the recent results achieved in the field of condensed matter physics and material research at

the laboratories in Košice and abroad. Scientific workers from laboratories from Košice as well as domestic and foreign guests give the talks. The program also involves presentation of PhD and diploma theses.

Recommended literature:
Scientific papers, which are specified according to the scope of work of a student.

Course language:
Slovak, English

Notes:
Presence form represents a standard form for the course, if a need arises, the course is performed using MS Teams.

Course assessment
Total number of assessed students: 13

abs	n
100.0	0.0

Provides: prof. Ing. Martin Orendáč, DrSc.

Date of last modification: 18.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ SFKL3a/22	**Course name:** Seminar in Condensed Matter Physics

Course type, scope and the method:
Course type: Practice
Recommended course-load (hours):
Per week: 1 **Per study period:** 14
Course method: present

Number of ECTS credits: 2

Recommended semester/trimester of the course: 5.

Course level: III.

Prerequisities:

Conditions for course completion:
Successful completing the course requires the students to participate in the seminars. If serious reasons (disease, family reasons, …) prevent the student to participate in the seminar, students may absent up to twice per semester without further consequences. For more frequent absence student will prepare presentation focused on a topic which will be consulted with the supervisor of the seminar. Student must have adequate knowledge about concepts, phenomena and laws discussed in the presented talks. Preparing a presentation is compulsory, the presentation is devoted to the results obtained during work on dissertation thesis which have been, or will be published. The student is encouraged to refer to the talks presented in the seminar. The number of credits takes into account participation of the student on the seminar, study of the recommended literature and preparation of the presentation. The level of the presentation is evaluated using the scale from 0 to 100 points. The minimum limit for successful completion of the course is to obtain 50 points from the subsequent point evaluation:
Rating scale
A 100-91
B 90-81
C 80-71
D 70-61
E 60-50
Fx 49-0

Learning outcomes:
Successful completing the course deepens knowledge of the student from the area in which student works on the dissertation thesis and from other areas of Condensed Matter Physics as well. Student will learn about scientific results of various research group from Košice and from their cooperating foreign institutions. The student is stimulated to participate in scientific discussion and to present own scientific results.

Brief outline of the course:
The program of seminars from condensed matter physics is prepared every year and is devoted to the recent results achieved in the field of condensed matter physics and material research at the laboratories in Košice and abroad. Scientific workers from laboratories from Košice as well

as domestic and foreign guests give the talks. The program also involves presentation of PhD and diploma theses.

Recommended literature:
Scientific papers, which are specified according to the scope of work of a student.

Course language:
Slovak, English

Notes:
Presence form represents a standard form for the course, if a need arises, the course is performed using MS Teams.

Course assessment
Total number of assessed students: 14

abs	n
100.0	0.0

Provides: prof. Ing. Martin Orendáč, DrSc.

Date of last modification: 18.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ SFKL3b/22	**Course name:** Seminar in Condensed Matter Physics

Course type, scope and the method:
Course type: Practice
Recommended course-load (hours):
Per week: 1 **Per study period:** 14
Course method: present

Number of ECTS credits: 2

Recommended semester/trimester of the course: 6.

Course level: III.

Prerequisities:

Conditions for course completion:
Successful completing the course requires the students to participate in the seminars. If serious reasons (disease, family reasons, …) prevent the student to participate in the seminar, students may absent up to twice per semester without further consequences. For more frequent absence student will prepare presentation focused on a topic which will be consulted with the supervisor of the seminar. Student must have adequate knowledge about concepts, phenomena and laws discussed in the presented talks. Preparing a presentation is compulsory, the presentation is devoted to the results obtained during work on dissertation thesis which have been, or will be published. The student is encouraged to refer to the talks presented in the seminar. The number of credits takes into account participation of the student on the seminar, study of the recommended literature and preparation of the presentation. The level of the presentation is evaluated using the scale from 0 to 100 points. The minimum limit for successful completion of the course is to obtain 50 points from the subsequent point evaluation:
Rating scale
A 100-91
B 90-81
C 80-71
D 70-61
E 60-50
Fx 49-0

Learning outcomes:
Successful completing the course deepens knowledge of the student from the area in which student works on the dissertation thesis and from other areas of Condensed Matter Physics as well. Student will learn about scientific results of various research group from Košice and from their cooperating foreign institutions. The student is stimulated to participate in scientific discussion and to present own scientific results.

Brief outline of the course:
The program of seminars from condensed matter physics is prepared every year and is devoted to the recent results achieved in the field of condensed matter physics and material research at the laboratories in Košice and abroad. Scientific workers from laboratories from Košice as well

as domestic and foreign guests give the talks. The program also involves presentation of PhD and diploma theses.

Recommended literature:
Scientific papers, which are specified according to the scope of work of a student.

Course language:
Slovak, English

Notes:
Presence form represents a standard form for the course, if a need arises, the course is performed using MS Teams.

Course assessment
Total number of assessed students: 15

abs	n
100.0	0.0

Provides: prof. Ing. Martin Orendáč, DrSc.

Date of last modification: 18.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ SFKL4a/22	**Course name:** Seminar in Condensed Matter Physics

Course type, scope and the method:
Course type: Practice
Recommended course-load (hours):
Per week: 1 **Per study period:** 14
Course method: present

Number of ECTS credits: 2

Recommended semester/trimester of the course: 7.

Course level: III.

Prerequisities:

Conditions for course completion:
Successful completing the course requires the students to participate in the seminars. If serious reasons (disease, family reasons, …) prevent the student to participate in the seminar, students may absent up to twice per semester without further consequences. For more frequent absence student will prepare presentation focused on a topic which will be consulted with the supervisor of the seminar. Student must have adequate knowledge about concepts, phenomena and laws discussed in the presented talks. Preparing a presentation is compulsory, the presentation is devoted to the results obtained during work on dissertation thesis which have been, or will be published. The student is encouraged to refer to the talks presented in the seminar. The number of credits takes into account participation of the student on the seminar, study of the recommended literature and preparation of the presentation. The level of the presentation is evaluated using the scale from 0 to 100 points. The minimum limit for successful completion of the course is to obtain 50 points from the subsequent point evaluation:
Rating scale
A 100-91
B 90-81
C 80-71
D 70-61
E 60-50
Fx 49-0

Learning outcomes:
Successful completing the course deepens knowledge of the student from the area in which student works on the dissertation thesis and from other areas of Condensed Matter Physics as well. Student will learn about scientific results of various research group from Košice and from their cooperating foreign institutions. The student is stimulated to participate in scientific discussion and to present own scientific results.

Brief outline of the course:
The program of seminars from condensed matter physics is prepared every year and is devoted to the recent results achieved in the field of condensed matter physics and material research at the laboratories in Košice and abroad. Scientific workers from laboratories from Košice as well

as domestic and foreign guests give the talks. The program also involves presentation of PhD and diploma theses.

Recommended literature:
Scientific papers, which are specified according to the scope of work of a student.

Course language:
Slovak, English

Notes:
Presence form represents a standard form for the course, if a need arises, the course is performed using MS Teams.

Course assessment
Total number of assessed students: 15

abs	n
100.0	0.0

Provides: prof. Ing. Martin Orendáč, DrSc.

Date of last modification: 18.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ SFKL4b/22	**Course name:** Seminar in Condensed Matter Physics
Course type, scope and the method: **Course type:** Practice **Recommended course-load (hours):** **Per week:** 1 **Per study period:** 14 **Course method:** present	
Number of ECTS credits: 2	
Recommended semester/trimester of the course: 8.	
Course level: III.	
Prerequisities:	
Conditions for course completion: Successful completing the course requires the students to participate in the seminars. If serious reasons (disease, family reasons, …) prevent the student to participate in the seminar, students may absent up to twice per semester without further consequences. For more frequent absence student will prepare presentation focused on a topic which will be consulted with the supervisor of the seminar. Student must have adequate knowledge about concepts, phenomena and laws discussed in the presented talks. Preparing a presentation is compulsory, the presentation is devoted to disertation thesis. Student, using the presentation, must give a talk at the seminar, duration of the talk is 45 min. The number of credits takes into account participation of the student on the seminar, study of the recommended literature, preparation of the presentation and the talk. The level of both, the presentation and talk, is evaluated using scale from 0 to 100 points. The minimum limit for successful completion of the course is to obtain 50 points from the subsequent point evaluation: Rating scale A 100-91 B 90-81 C 80-71 D 70-61 E 60-50 Fx 49-0	
Learning outcomes: Successful completing the course deepens knowledge of the student from the area in which student works on the dissertation thesis and from other areas of Condensed Matter Physics as well. Student will learn about scientific results of various research group from Košice and from their cooperating foreign institutions. The student is stimulated to participate in scientific discussion an to present own scientific results.	
Brief outline of the course: The program of seminars from condensed matter physics is prepared every year and is devoted to the recent results achieved in the field of condensed matter physics and material research at the laboratories in Košice and abroad. Scientific workers from laboratories from Košice as well	

as domestic and foreign guests give the talks. The program also involves presentation of PhD and diploma theses.

Recommended literature:
Scientific papers, which are specified according to the scope of work of a student.

Course language:
Slovak, English

Notes:
Presence form represents a standard form for the course, if a need arises, the course is performed using MS Teams.

Course assessment
Total number of assessed students: 15

abs	n
100.0	0.0

Provides: prof. Ing. Martin Orendáč, DrSc.

Date of last modification: 18.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ SAA/18	**Course name:** Sensors and actuators based on selected physical phenomena

Course type, scope and the method:
Course type: Lecture
Recommended course-load (hours):
Per week: 1 **Per study period:** 14
Course method: present

Number of ECTS credits: 2

Recommended semester/trimester of the course: 2., 4.

Course level: II., III.

Prerequisities:

Conditions for course completion:
To successfully complete the course, the student must demonstrate sufficient knowledge of the basics of sensors and actuators operating on the basis of physical phenomena with emphasis on basic concepts, properties and parameters of sensors and actuators, static sensor parameters, transmission characteristics and calibration, accuracy, sensitivity, resolution, selectivity, working range, hysteresis and dynamic parameters. Basic physical phenomena used in microsensors such as piezoelectric effect, piezoresistive effect, magnetoresistance effect, Hall effect, Seebeck effect, Peltier effect, magnetostrictive effect, electrostrictive effect, pyroelectric effect. Description of the principle of operation of sensors and actuators based on mechanical, thermal, magnetic, and biochemical domains.
The credit evaluation of the course takes into account the following student workload:
1 credits: direct teaching and self-study of recommended supplementary literature,
1 credit: independent preparation for the final test and its successful completion.
The minimum threshold for completing the course is to obtain at least 50% of the total score, using the following rating scale: A (90-100%), B (80-89%), C (70-79%), D (60- 69%), E (50-59%), F (0-49%).

Learning outcomes:
After completing the lectures and successfully passing the final test, the student will demonstrate the knowlage of the standard content of the course, which is defined by the brief content of the course and the recommended literature. The result of education is:
a) Creation of the necessary terminology and knowledge base for understanding the operation of sensors and actuators based on selected physical phenomena.
b) Supplementation and summarization of knowledge in the field of physical phenomena and materials with the possibility of use in sensors and actuators.
c) Possibilities of using sensors and actuators in practice.

Brief outline of the course:
Sensors and actuators - introductory terms and definitions. Properties and parameters of sensors and actuators. Basic physical phenomena used in sensors and actuators. Sensors - basic terms and definitions. Mechanical domain based sensors. Thermal domain based sensors. Magnetic domain based sensors. Radiation sensors. Chemical sensors. Tactile sensors. Actuators - basic concepts

and classification. Electrostatic actuators. Piezoelectric actuators. Actuators based on magnetic principles. Thermal actuators. Optical actuators. Mechanical actuators. Chemical actuators.

Recommended literature:

1. 1. M. Husák, Mikrosenzory a mikroaktuátory, Nakladatelství Academia, Praha, (2008)
2. S. Chikazumi, Physics of Ferromagnetism, Oxford University Press, USA (2009)
3. S. Tumanski, Handbook of Magnetic Measurements, CRC Press (2011)
4. N. A. Spaldin, Magnetic Materials: Fundamentals and Device Applications, Cambridge University Press (2003)

Course language:
slovak, english

Notes:
Lectures can be done at presence form or online form using MS Teams. Education form is updated at the begining of the subject

Course assessment
Total number of assessed students: 6

A	B	C	D	E	FX	N	P
16.67	0.0	0.0	0.0	0.0	0.0	0.0	83.33

Provides: prof. RNDr. Rastislav Varga, DrSc., RNDr. Ladislav Galdun, PhD.

Date of last modification: 27.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ SPM1/14	**Course name:** Special Practicum I

Course type, scope and the method:
Course type: Practice
Recommended course-load (hours):
Per week: 3 **Per study period:** 42
Course method: present

Number of ECTS credits: 5

Recommended semester/trimester of the course: 1., 3.

Course level: III.

Prerequisities:

Conditions for course completion:
To successfully complete the course, the student must complete all experimental tasks determined by the syllabus and evaluate the experimental results in the form of a protocol.
The condition for the implementation of the practical task is sufficient theoretical training at home.
The credit evaluation of the course takes into account the following student workload:
1 credit: self-study of recommended literature and subsequent direct teaching
1 credits: realization of experimental exercise and subsequent defense of measuring procedure
2 credits: elaboration and submission of protocols from measurements, which are evaluated
1 credit: final presentation of the defense of the measurement procedure and analysis of experimental data from the selected task.

Learning outcomes:
The result of education is:
1) Acquisition of basic abilities and skills in experimental research of selected phenomena in areas of magnetic and structural properties of materials.
2) Analysis and interpretation of results and experience in preparing the protocols on measurement and measurement results.

Brief outline of the course:
Measurement of electrical resistivity (S. Dobák).
Measurement of initial magnetization curves and hysteresis loops in quasi-static and dynamic regime (S. Dobák).
Measurement of complex permeability spectra (S. Dobák).
Observation of the domain structure of ferromagnets by colloidal technique using optical microscope. (A. Zeleňáková)
Observation of the domain structure of ferromagnets by the MFM method. (A. Zeleňáková)
Measurement of temperature and field dependence of magnetization of magnetic substances using a device
MPMS based on SQUID. (A. Zeleňáková)
Magnetoimpedance measurement. (L. Galdun)
Measurement of domain wall dynamics (L. Galdun)
Magneto-optical measurements using the Kerr effect. (L. Galdun)

Study of atomic structure using powder XRD (J. Bednarčík)
Study of atomic structure using single crystal XRD diffraction (J. Bednarčík)
Study of structural substances using SAXS (J. Bednarčík)

Recommended literature:

Tumanski S, Handbook of magnetic measurements, CRC press, 2011.
Fiorillo F, Characterization and Measurement of Magnetic Materials, Elsevier, 2004.
Hajko V, Potocký L., Zentko A.: Magnetizačné procesy, Alfa, 1982, Bratislava.
Dufek M., Hrabák J., Trnaka Z.: Magnetická měření, SNTL, 1964, Praha

Course language:
english

Notes:
Teaching is carried out in person. If necessary, part of the teaching can be realized remotely using the MS Teams or BBB tool. The form of teaching will be specified by the teacher at the beginning of the semester, it is continuously updated.

Course assessment
Total number of assessed students: 45

abs	n
100.0	0.0

Provides: doc. RNDr. Adriana Zeleňáková, PhD., RNDr. Ladislav Galdun, PhD., RNDr. Samuel Dobák, PhD., RNDr. Jozef Bednarčík, PhD., univerzitný docent

Date of last modification: 01.10.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ SPM2/14	**Course name:** Special Practicum II

Course type, scope and the method:
Course type: Practice
Recommended course-load (hours):
Per week: 3 **Per study period:** 42
Course method: present

Number of ECTS credits: 5

Recommended semester/trimester of the course: 2., 4.

Course level: III.

Prerequisities:

Conditions for course completion:
Successful completing the course requires the students to demonstrate sufficient knowledge and skills in experimental study of selected properties of solids at predominantly low temperatures. The number of credits takes into account participation of the student on the laboratory exercises (2 credits), study of the recommended literature (2 credit), and preparation of the reports (1 credit). Number of credits for study of the recommended literature is related to the fact that each report, apart from detailed description of experimental tasks and experimental data acquisition, should contain solution of physical problems formulated by the teacher which are relevant to the scope of the exercise. Activity and skills in participating experiments and the level of the report which should contain theoretical background, discussion how formulated goals were met and/or acquisition of the experimental data are evaluated. Submitting all reports represent necessary condition for passing the course. Activity of the student during conducting experiments is evaluated in range 0 – 25 points. Quality of the report is evaluated using the scale 0 – 100 points. The minimum limit for successful completion of the course is to obtain 50 points in total from the subsequent point evaluation:
Rating scale
A 100-91
B 90-81
C 80-71
D 70-61
E 60-50
Fx 49-0

Learning outcomes:
Obtaining fundamental theoretical, experimental skills and ability to analyze the obtained experimental data in selected areas of physical research in condensed matter, primarily at low temperatures.

Brief outline of the course:
Exercises n. 1. – 6. are given by prof. Ing. M. Orendáč, DrSc., exercises n. 7. – 12. are given by doc. RNDr. E. Čižmár, PhD.

1.Calibration of resistance thermometers. Choice of a function for the analysis of the calibration curve, determination of the degree of the fitting polynom. Analysis of the temperature dependence of the relative deviation.
2. Determination of the magnitude of the spin from calorimetric data. Determination of the molar specific heat. Standard extrapolations for the calulation of the magnetic entropy at low and high temperatures. Calculation of contributions to magnetic entropy.
3. Magnetocaloric effect. Calculation of the temperature dependence of the isothermal change of magnetic entropy from calorimetric data. Comparisson of the data for quantum spin chain and S=1/2 paramagnet.
4. Study of spin dynamics from the data of alternating susceptibility. Cole – Cole diagram and its construction. Width of the distribution of relaxation times. Temperature dependence of relaxation processes in a selected model system.
5. Study of critical behavior from calorimetric data. Analysis of the specific heat data in a critical region for different magnetic fields. Critical indexes, their dependence on external magnetic field. Comparisson of the values of critical indexes with predictions for selected models.
6. Experimental study of spin-glass state. Analysis of static magnetic susceptibility data obtained in "zero-field cooled" and "field-cooled" regimes. Study of the influence of external magnetic field. Analysis of alternating susceptibility data obtained at various temperatures. Study of the effect of the excitation frequency. Construction of Cole-Cole diagrams.
7. Vacuum technique. Methods of leak detection in vacuum systems.
8. Preparation of the samples. Specific heat measurements in cryogenic devices. Analysis and intrepretation of the experimental results.
9. Susceptibility and magnetization of magnetic systems. Preparation of the sample, setting sequence of measurement for SQUID magnetometer.
10. Analysis of the experimental data of magnetization and susceptibility (Curie – Weiss law, Brillouin function, determination of the nature of exchange coupling)
11. Electron paramagnetic resonance in magnetic systems. Preparation of the sample, collection of the data. Analysis of the obtained data (Determination of the anisotropy of g-factor, analysis of the resonance linewidth)
12. Electrical resistivity in normal metals and superconductors. Preparation of the sample, setting sequence of measurement for PPMS device. Analysis of the obtained data (determination of RRR, residual resistivity, critical temperature of a superconductor).

Recommended literature:

J. H. Moore and N. D. Spencer: Encyclopedia o Chemical Physics and Physical Chemistry Vol. I., II. and III., IoP Publishing Ltd. 2001, ISBN 0750303131.
Selected scientific publications.
F. Pobell, Methods and Matter at Low Temperatures, Springer Verlag, Berlin Heidelberg, 1992.
J. A. Mydosh, Spin glasses: An Experimental Introduction, Taylor&Francis, 1993.
Selected scientific papers with appropriate scope.

Course language:
slovak, english

Notes:
Presence form represents a standard form for the course, if a need arises, the course can be partially performed using MS Teams.

Course assessment
Total number of assessed students: 42

abs	n
100.0	0.0

Provides: doc. RNDr. Erik Čižmár, PhD., prof. Ing. Martin Orendáč, DrSc.

Date of last modification: 22.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: Dek. PF UPJŠ/JSD/14	**Course name:** Spring School for PhD Students

Course type, scope and the method:
Course type: Lecture
Recommended course-load (hours):
Per week: **Per study period:** 4d
Course method: distance, present

Number of ECTS credits: 2

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Active participation in the Spring School of PhD students of UPJŠ.

Learning outcomes:
By actively participating in the Spring School of PhD Students of UPJŠ, the PhD student demonstrates a high level of ability to process the issues of his dissertation for a multidisciplinary audience with an emphasis on clarifying the motivation, scientific problem, processing methodology and own contribution to the solution of the selected topic. The PhD student demonstrates the ability to professionally discuss various research topics, present his own positions and accept a plurality of opinions. Demonstrates the ability to communicate research results to a wider professional audience with adequate means and through the Slovak language.

Brief outline of the course:
1. Interdisciplinary lectures from the fields of medicine, natural sciences, law, public affairs, humanities. Lecturers - top foreign or national experts from the mentioned fields.
2. Scientific lectures in sections created within related disciplines. Lecturers - top experts from UPJŠ from the mentioned fields.
3. Scientific contributions of PhD students in sections of related fields.
4. Panel discussions on the issue of PhD studies and current trends in the development of scientific disciplines at UPJŠ.

Recommended literature:
Proceedings of the Spring School of Doctoral Students.

Course language:

Notes:

Course assessment
Total number of assessed students: 202

abs	n
100.0	0.0

Provides: doc. RNDr. Andrea Straková Fedorková, PhD.

Date of last modification: 08.11.2022
Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ SVM/07	**Course name:** Structural properties of materials
Course type, scope and the method: **Course type:** Lecture **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 28 **Course method:** present	
Number of ECTS credits: 5	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: To successfully complete the course, the student must demonstrate sufficient understanding of the basic concepts of condensed matter physics and physical metallurgy. On the basis of the acquired knowledge, he / she is able to follow up on specialized courses in condensed matter physics, which are provided by the Department of FKL on the basis of the orientation of his research. These are mainly courses in the field and structure and properties of KL. To obtain an evaluation, the student must meet the requirements of a written test on the topic of crystal lattice disorders. Other topics of the course will be the subject of an oral exam. The credit evaluation of the course takes into account the following student workload: direct teaching 2 credits, self-study of recommended supplementary literature - 1 credit, continuous study for test and evaluation - 2 credits. The minimum limit for obtaining the evaluation is 50% of the sum of the points from the test and the oral exam. The maximum value of points from the test is 30% of the total evaluation. The rating scale is determined as follows: A (90-100%), B (80-89%), C (70-79%), D (60-69%), E (50-59%), F (0- 49%) 50% based on the result of the exam from the syllabus.	
Learning outcomes: By completing the course, the student will demonstrate adequate mastery of the content standard of the course, which is defined by brief content and recommended literature. Theoretical mastery of the basics of defects in crystalline materials, diffusion in solids, thermodynamics of materials with an orientation to phase equilibrium and phase transformations.	
Brief outline of the course: OK	
Recommended literature: 1. P. Kratochvíl, P. Lukáč, B. Sprušil, Úvod do fyziky kovů I.SNTL/ALFA 1984 2. J.D. Verhoeven, Fundamentals Physical Metallurgy, 1975, John Wiley & Sons. 3. L. Ptáček a kolektiv, Nauka o materiálu I., 2003, Akademické nakladatelství CERM, s.r.o.,	
Course language: Slovak, English	
Notes:	

Course assessment
Total number of assessed students: 3

N	P
0.0	100.0

Provides: Ing. Pavel Diko, DrSc.

Date of last modification: 21.10.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ VPSV/22	**Course name:** Supervision of Student's Scientific Activity

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: **Per study period:**
Course method: distance, present

Number of ECTS credits: 8

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Supervision of Student's Scientific Activity

Learning outcomes:
By guiding a student within the SOČ or ŠVOČ, the PhD student demonstrates broad and scientifically based knowledge in the field of study, as well as knowledge of a wide range of methods and approaches. Demonstrates the ability to critically assess a professional problem and its proposed solution, as well as to evaluate it and possibly propose another solution. He applies knowledge and skills from the field of pedagogical sciences to his own field.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 5

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ VZP/22	**Course name:** Supervisor/consultant of fianl thesis
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week: Per study period:** **Course method:** distance, present	
Number of ECTS credits: 8	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: Supervisor of the final thesis.	
Learning outcomes: By supervising the final thesis, the PhD student demonstrates broad and scientifically based knowledge in the field of study, as well as knowledge of a wide range of methods and approaches. Demonstrates the ability to critically assess a professional problem and its proposed solution, as well as to evaluate it and possibly propose another solution. He applies knowledge and skills from the field of pedagogical sciences to his own field.	
Brief outline of the course:	
Recommended literature:	
Course language:	
Notes:	
Course assessment Total number of assessed students: 2	
abs	n
100.0	0.0
Provides:	
Date of last modification: 08.11.2022	
Approved: prof. Ing. Martin Orendáč, DrSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ PPC1/22	**Course name:** Teaching activities 1h/s

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: **Per study period:**
Course method: distance, present

Number of ECTS credits: 2

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Direct teaching activity 1 semester hour

Learning outcomes:
Through pedagogical activity, the PhD student demonstrates the ability to transfer and integrate knowledge from his own field of study into education. He is able to select and apply the right techniques and strategies of study group management, higher education and evaluation of learning outcomes. He is capable of designing and implementing part of the educational process in accordance with current trends in higher education and the requirements placed on the level of communication and digital competencies.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 6

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ PPC2/22	**Course name:** Teaching activities 2h/s
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week: Per study period:** **Course method:** distance, present	
Number of ECTS credits: 4	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: Direct teaching activity 2 semester hours	
Learning outcomes: Through pedagogical activity, the PhD student demonstrates the ability to transfer and integrate knowledge from his own field of study into education. He is able to select and apply the right techniques and strategies of study group management, higher education and evaluation of learning outcomes. He is capable of designing and implementing part of the educational process in accordance with current trends in higher education and the requirements placed on the level of communication and digital competencies.	
Brief outline of the course:	
Recommended literature:	
Course language:	
Notes:	
Course assessment Total number of assessed students: 6	
abs	n
100.0	0.0
Provides:	
Date of last modification: 08.11.2022	
Approved: prof. Ing. Martin Orendáč, DrSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ PPC3/22	**Course name:** Teaching activities 3h/s
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week: Per study period:** **Course method:** distance, present	
Number of ECTS credits: 6	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: Direct teaching activity 3 semester hours	
Learning outcomes: Through pedagogical activity, the PhD student demonstrates the ability to transfer and integrate knowledge from his own field of study into education. He is able to select and apply the right techniques and strategies of study group management, higher education and evaluation of learning outcomes. He is capable of designing and implementing part of the educational process in accordance with current trends in higher education and the requirements placed on the level of communication and digital competencies.	
Brief outline of the course:	
Recommended literature:	
Course language:	
Notes:	
Course assessment Total number of assessed students: 10	
abs	n
100.0	0.0
Provides:	
Date of last modification: 08.11.2022	
Approved: prof. Ing. Martin Orendáč, DrSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ PPC4/22	**Course name:** Teaching activities 4h/s
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week: Per study period:** **Course method:** distance, present	
Number of ECTS credits: 8	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: Direct teaching activity 4 semester hours	
Learning outcomes: Through pedagogical activity, the PhD student demonstrates the ability to transfer and integrate knowledge from his own field of study into education. He is able to select and apply the right techniques and strategies of study group management, higher education and evaluation of learning outcomes. He is capable of designing and implementing part of the educational process in accordance with current trends in higher education and the requirements placed on the level of communication and digital competencies.	
Brief outline of the course:	
Recommended literature:	
Course language:	
Notes:	
Course assessment Total number of assessed students: 7	

abs	n
100.0	0.0

Provides:	
Date of last modification: 08.11.2022	
Approved: prof. Ing. Martin Orendáč, DrSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚCHV/ TA1/03	**Course name:** Thermal Analysis
Course type, scope and the method: **Course type:** Lecture / Practice **Recommended course-load (hours):** **Per week:** 2 / 1 **Per study period:** 28 / 14 **Course method:** present	
Number of ECTS credits: 5	
Recommended semester/trimester of the course:	
Course level: II., III.	
Prerequisities:	
Conditions for course completion: Successful completion of a written test. In accordance with the UPJŠ Study Regulations, successful completion is conditioned by obtaining at least 51% of the maximum possible points. Active and mandatory participation in seminars, elaboration of seminar papers. Each student will prepare one seminar paper on a given topic.	
Learning outcomes: The student will gain information about the methods of thermal analysis used to study and characterize the physical and chemical properties of inorganic and organic compounds as well as solid materials during heating, the equipment used to study thermal properties and the reaction kinetics of decomposition processes. Mastering the basic principles and methods of thermal analysis and its use to characterize changes in the physical and chemical properties of the substance during heating (inorganic compounds and materials, organic substances and pharmaceuticals).	
Brief outline of the course: 1. Introduction, history, definition and development of thermal analysis methods. Terminology of thermal analysis. 2. Classification of thermal analysis methods. Overview of individual thermoanalytical techniques and measured parameters. Description of thermoanalytical curves. Isothermal and non-isothermal methods of thermal analysis. 3.) Equipment and instruments used in thermal analysis. 4.) Thermocouples, their construction and division. Temperature measurement method, thermocouples, resistance thermometers, thermistors. 5.) Classification of processes monitored by thermal analysis (solid-solid reaction, solid-liquid, solid-gas, melt reactions). 6.) Thermogravimetry methods (TG / DTG). Principle, methods, thermal scales, types of scales, temperature measurement. 7.) DSC and DTA method (principle, method of connecting thermocouples, sample carriers, registration devices). 8.) Other methods of thermal analysis - emanation thermal analysis, thermodilatometry, thermomechanical analysis, thermomagnetometry.	

9.) Analysis of released gases and coupled techniques in thermal analysis (IČ, MS)
10.) Basics of kinetics.
11.) Methods for determining the kinetics of processes from thermoanalytical measurements (ASTM, OFW, Friedman analysis, model-free methods)
12. Presentation and publication of results of thermoanalytical measurements. Application of TA methods to inorganic, organic materials and minerals.

Recommended literature:

1. Zeleňák, V.: Termická analýza, Interný učebný text, PF UPJŠ, 2020.
2. Györyová K., Balek V.: Termická analýza, PF UPJŠ, Edičné stredisko, Košice, 1992.
3. Brown E.M., Gallagher P.K.: Handbook od Thermal Analysis and Calorimetry , Elsevier Amsterdam 2008.
4. Bohne G.H., Hemminger W.F., Flammerschein H.J.. Differential Scanning Calorimetry, Springer Verlag Berlin 2003
5. Blažek A.: Termická analýza, Praha, 1972, SNTL
6. Wendlandt W. W.: Thermal Methods of Analysis, 2. vydanie, New York, 1985.
7. Šesták J.: Měření termofyzikálních vlastností pevných látek, Academia Praha, 1982.

Course language:
Slovak, English

Notes:
The course is standardly realized in full-time form, in case of necessary circumstances by distance.

Course assessment
Total number of assessed students: 89

A	B	C	D	E	FX	N	P
58.43	15.73	8.99	1.12	1.12	0.0	0.0	14.61

Provides: prof. RNDr. Vladimír Zeleňák, DrSc.

Date of last modification: 21.11.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/ TS/12	**Course name:** Thermodynamics of Superconductors

Course type, scope and the method:
Course type: Lecture
Recommended course-load (hours):
Per week: 2 **Per study period:** 28
Course method: present

Number of ECTS credits: 3

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Conditions are: to pass the final exam where the student is to prove satisfactory understanding of basic concepts and models used for description of the heat capacity of superconductors. Apart from presence on the course the student is obliged to study scientific papers assigned by the teacher (specific publications related to the heat capacity of particular superconducting materials). Student is obliged also to elaborate home assignment in relation to practical laboratory exercise realized during semester. Minimum level for successful passing the exam is 51 % from the total score, which takes into account all kind of activities with relevant weight.
The scale: A - 91%-100% points, B - 81%-90% points, C - 71%-80% points,
D - 61%-70% points, E - 51%-60% points.

Learning outcomes:
After successful passing the student will understand basic theoretical and experimental aspects of thermodynamic properties of superconductors, with special emphasis on the experimental method of modulated calorimetry. The student will acquire practical experience with preparation and realization of experiment to determine the heat capacity using this method. From the voltage reading the student will be able to calculate heat capacity of the sample. From temperature and field dependence of the heat capacity, the student will manage to decide which type of superconductor the sample is (s-wave or d-wave), to determine the coupling strength, upper critical magnetic field and other characteristic features or properties of superconducting material.

Brief outline of the course:
Vargaeštoková: 1., 2., 3., 8., 9., 11. Kačmarčík: 4., 5., 6., 7., 10., 12.
1. Introduction into superconductivity. Elementary properties of superconductors (zero resistivity, Meissner effect), energy gap, electron-phonon interaction, symmetry of the energy gap, types of superconductors (type I, type II superconductors), phase diagrams Magnetic field vs. Temperature, superconducting vortices.
2. Thermodynamics of the phase transitions. Thermodynamic potentials, their relations and related quantities.
3. Thermodynamic properties of superconductors. Entropy, specific heat in normal and superconducting state, thermodynamic critical field, upper critical field.

4. Heat capacity measurement methods. Adiabatic, relaxation, pulsed, modulated heat capacity measurements – theory, comparison, advantages and disadvantages, choice of a proper method in specific cases.
5. Modulated calorimetry – theory. Calculation of thermal balance, important relaxation constants, relations between distinct part of the experimental setup, calculation of the heat capacity from oscillations of the temperature for an ideal case, corrections of the heat capacity for a real case, estimation of thermal conductance between the sample and thermal reservoir.
6. Modulated calorimetry – experimental aspects. Experimental setup, measurement of particular physical properties, choice of a frequency for the measurement – frequency test; accurate temperature measurement – calculation of the Seebeck coefficient, correction of the thermal sensors in magnetic field; corrections of the amplifier; regulation of LED diode (temperature stabilization), relation between the diode power and sample temperature, relation between frequency of the heating and measured signal.
7. Modulated calorimetry – data treatment. Programs for a measurement automation and data acquisition – LabView environment; heat capacity data treatment – calculation of the heat capacity from the measured signal, implementation of the corrections (magnetic field corrections, phase shift, ...).
8. Heat capacity of a superconductor in zero magnetic field. Heat capacity in normal and superconducting state – contributions of electrons and lattice; Sommerfeld coefficient; calculation of electronic heat capacity in superconducting state, temperature dependence at low temperatures (s-wave superconductor), overall temperature dependence – alpha model; energy gap value determination.
9. Heat capacity of a superconductor in non-zero magnetic field. Determination of the upper critical field; field dependence of the Sommerfeld coefficient and its relation with other properties of superconductor, corrections in the low-field range (relation between applied magnetic field and the one induced in the sample); influence of superconductor properties on the Sommerfeld coefficient (shrinking of the vortex core, anisotropic energy gap, ...).
10. Experimental determination of the heat capacity of specific superconductor (laboratory excercise).
11. Special cases of superconductors. Heat capacity of a two-gap superconductor – temperature and field dependence of the heat capacity for two-gap superconductors with different anisotropy of the bands – MgB2 and NbS2. Heat capacity of the high-temperature superconductors.
12. Modulated calorimetry – overview of different applications. Modulated micro-calorimetry and nano-calorimetry; modulated calorimetry of organic and biological substances; modulated differential scanning calorimetry.

Recommended literature:

M. Tinkham, Introduction to superconductivity, McGraw-Hill, Inc., New York,1996.
Yaakov Kraftmakher, Modulation Calorimetry: Theory And Applications, Springer-Verlag, 2004.
Specific heat of solids, Edited by C. Y. Ho, Hemisphere publishing corporation, 1988.

Course language:
Slovak, English

Notes:
The subject is intended for the presence form, in case of necessity it will be realized in distance form using the MS TEAMS environment.

Course assessment
Total number of assessed students: 10

N	P
0.0	100.0

Provides: RNDr. Jozef Kačmarčík, PhD., RNDr. Zuzana Vargaeštoková, PhD.

Date of last modification: 23.09.2021

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚFV/ KZP/22	**Course name:** Thesis consultant
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week: Per study period:** **Course method:** distance, present	
Number of ECTS credits: 4	
Recommended semester/trimester of the course:	
Course level: III.	
Prerequisities:	
Conditions for course completion: Final thesis consultant.	
Learning outcomes: By consulting the final thesis, the PhD student demonstrates broad and scientifically based knowledge in the field of study, as well as knowledge of a wide range of methods and approaches. Demonstrates the ability to critically assess a professional problem and its proposed solution, as well as to evaluate it and possibly propose another solution. He applies knowledge and skills from the field of pedagogical sciences to his own field.	
Brief outline of the course:	
Recommended literature:	
Course language:	
Notes:	
Course assessment Total number of assessed students: 6	
abs	n
100.0	0.0
Provides:	
Date of last modification: 08.11.2022	
Approved: prof. Ing. Martin Orendáč, DrSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/POVK/22	**Course name:** Work in Organizing Committee of Conference

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: Per study period:
Course method: distance, present

Number of ECTS credits: 3

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Work in the organizing committee of the conference

Learning outcomes:
By working in the organizing committee of the conference, the PhD student demonstrates the abilities and competences to organize a scientific or professional event independently or in a team, to manage the implementation in terms of time and content, to communicate effectively verbally and in writing using various technical means as needed, including in a foreign language at a professional level with various types of people, if necessary, correctly recommend solutions or make independent decisions.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 18

abs	n
100.0	0.0

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚFV/PDS/22	**Course name:** Writing Dissertation Work

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: **Per study period:**
Course method: distance, present

Number of ECTS credits: 20

Recommended semester/trimester of the course:

Course level: III.

Prerequisities:

Conditions for course completion:
Obtaining the required number of credits in the prescribed composition according to the UPJŠ study regulations, preparation and defense of the thesis, successfully completed dissertation examination

Learning outcomes:
The PhD student demonstrated the prerequisites for successful continuation of the study by fulfilling the conditions prescribed by the study regulations for the study and scientific part of the doctoral study related to the topic of the dissertation.

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 26

N	P
3.85	96.15

Provides:

Date of last modification: 08.11.2022

Approved: prof. Ing. Martin Orendáč, DrSc.