Skoltech
Skolkovo Institute of Science and Technology

Course Syllabus

Course Title (in English)	Research seminar "Modern Problems of Mathematical Physics"
Course Title (in Russian)	Научно-исследовательский семинар "Современные проблемы математической физики"
Lead Instructor(s)	Gavrylenko, Pavlo

Contact Person	Pavlo Gavrylenko
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1. Annotation

Course Description

Course "Modern problems of mathematical physics" is a student seminar, so participants are expected to give talks based on the modern research papers. Current topic of the seminar can vary from time to time. Topics that were already covered, or can be covered in the future, are: classical integrable equations, complex curves and their theta-functions, quantum integrable models (quantum-mechanical and field-theoretical), models of statistical physics, stochastic integrability, quantum/classical duality, supersymmetric gauge theories, etc.

Course Prerequisites / Recommendations	Basic knowledge of classical/quantum mechanics and classical/quantum field theory: Lagrangian/Hamiltonian formalism, operator formalism in quantum mechanics, Gaussian integration.

Аннотация

Курс "Современные задачи математической физики" это студенческий семинар, потому от участников ожидается, что они будут делать доклады на основе современных статей. Текущая тема семинара может время от времени меняться. Сюжеты, которые уже рассматривались, или могут быть рассмотрены в будущем: классические интегрируемые уравнения, комплексные кривые и их тэта-функции, квантовые интгерируемые системы (квантово-механические и теоретико-полевые), модели статфизики, стохастическая интегриуемость, квантово-классическая дуальность, суперсимметричные калибровочные теории, и т.д.

2. Structure and Content

Course Academic Level	Master-level course suitable for PhD students
Number of ECTS credits	6

Topic	Summary of Topic	Lectures (# of hours)	Seminars (# of hours)	Labs (# of hours)
Seiberg Witten / dimers / Painleve	Seiberg-Witten theory and thermodynamics of dimers. Limit shapes in the dimer models. Classical and quantum Painleve III equation, blow-up relations and monopole expansions at infinity.			
Quantum-classical correspondence	Master T-operator of the XXZ chain as tau function of the mKP hierarchy. Dynamics of zeroes of the tau function. Quantum-classical correspondence.			
Other topics	Yangians of other series, mirror symmetry, scattering amplitudes, integrable stochastics, etc.			

3. Assignments

Assignment Type	Assignment Summary
Presentation	To give a talk on some mathematical physics topic
Other	To participate in the discussions during seminars, to understand what is going on

4. Grading

Type of Assessment	Graded

Grade Structure	

Activity Type	Activity weight, %
Attendance	70
Presentation	30

Grading Scale

A:	86
B:	76
C:	66
D:	56
E:	46
F:	0
Attendance Requirements	Mandatory with Exceptions

5. Basic Information

Course Stream	Science, Technology and Engineering (STE)
Course Term (in context of Academic Year)	Term 1 Term 2 Term 3 Term 4
Course Delivery Frequency	Every year

Students of Which Programs do You Recommend to Consider this Course as an Elective?

Masters Programs	PhD Programs
Mathematical and Theoretical Physics	Mathematics and Mechanics

Course Tags	Math Physics

6. Textbooks and Internet Resources

Papers	DOI or URL
A. Zabrodin, Lectures on nonlinear integrable equations and their solutions	https://arxiv.org/abs/1812.11830
Alexander Alexandrov, Anton Zabrodin, Free fermions and tau-functions	https://arxiv.org/abs/1212.6049

7. Facilities

8. Learning Outcomes

Knowledge
Dependins on topics of the seminars (some subset of: Seiberg-Witten prepotential, Painleve equations, dimer models, classical integrable systems of KP type, quantum integrable systems of XXZ type, etc.)

Skill
Ability to understand scientific talks of not very high level of complexity

Experience
To prepare talks and to participate in the discussions

9. Assessment Criteria

Input or Upload Example(s) of Assigment 1:

Select Assignment 1 Type	Presentation
Input Example(s) of Assignment 1 (preferable)	To give a talk on some mathematical physics topic
Assessment Criteria for Assignment 1	At least one talk

Input or Upload Example(s) of Assigment 2:

Select Assignment 2 Type	Other

Input Example(s) of Assignment 2 (preferable)	To participate in the discussions during seminars, to understand what is going on

Input or Upload Example(s) of Assigment 3:

Input or Upload Example(s) of Assigment 4:

Input or Upload Example(s) of Assigment 5:

10. Additional Notes