

Course Syllabus

Course Title Research seminar "Modern Problems of Mathematical Physics"

Course Title (in Russian) Научно-исследовательский семинар "Современные проблемы математической физики"

Lead Instructor Marshakov, Andrey

Co-Instructor Marshakov, Andrey

Co-Instructor

First Name	Last Name
Alexey	Litvinov

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 theta-functions, quantum integrable models (quantum-mechanical and field-theoretical), models of statistical physics, stochastic integrability, quantum/classical duality, supersymmetric gauge theories, cluster algebras etc.

Course Description (in Russian)

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 тэта-функции, квантовые интегрируемые системы (квантово-механические и теоретико-полевые), модели статфизики, стохастическая интегрируемость, квантово-классическая дуальность, суперсимметричные калибровочные теории, кластерные алгебры и т.п

2. Basic Information

Number of ECTS credits

6

Course Prerequisites / Recommendations

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

Type of Assessment

Graded

Mapping from grades to percentage:

A:	86
B:	76
C:	66
D:	56
E:	46
F:	0

Term

Term 1

Term 2

Term 3

Term 4

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

Maximum Number of Students

	Maximum Number of Students
Overall:	15
Per Group (for seminars and labs):	

Course Stream

Research & MSc Thesis Project

3. Course Content

Topic	Summary of Topic	Lectures (# of hours)	Seminars (# of hours)	Labs (# of hours)
Supersymmetry	Lorentz and Poincare symmetry in quantum field theory. Structure of algebra and representations. Supersymmetric extension. Representations of algebra of supersymmetry. Massless multiplet. Witten index.	2	2	

Topic	Summary of Topic	Lectures (# of hours)	Seminars (# of hours)	Labs (# of hours)
Supersymmetric Yang-Mills theory	Supersymmetric Lagrangians, Wess-Zumino model. Vector multiplet in 4 dimensions, Lagrangian for the vector field. N=1 and N=2 supersymmetric electrodynamics. Supersymmetric Yang-Mills theory.	2	4	
Classical analysis.	Structure of vacua in supersymmetric Yang-Mills theory. Spectrum of excitations. BPS states.	2	4	
Quantum Yang-Mills theory	Properties of the beta-functions. Instantons and monopoles. Renormalization theorems.	2		
Seiberg-Witten theory	Non-perturbative analysis of N=2 supersymmetric gauge theory	3		

4. Learning Outcomes

Skoltech Learning Outcomes are indicated as per [Skoltech Learning Outcomes Framework](#).

5. Assignments and Grading

Assignment Type	Assignment Summary	% of Final Course Grade
Presentation	To give a talk on some mathematical physics topic	70
Other	To participate in the discussions during seminars, to understand what is going on	30

6. Assessment Criteria

Assignment 1 Type

Presentation

Sample of Assignment 1

Talk at a seminar

Assessment Criteria for Assignment 1

To make a presentation on current research individual work - assessment depends on its level, analysis, obtained research results, their explanation

Assignment 2 Type

Other

Knowledge of main facts, logical consistency, informativeness, knowledge of main trends

7. Textbooks and Internet Resources

You can request at most two required textbooks. Additionally, you can suggest up to nine recommended textbooks.

Required Textbooks	ISBN-13 (or ISBN-10)
Landau Lifshits	

Recommended Textbooks	ISBN-13 (or ISBN-10)
Landau	

Papers	DOI or URL
A. Zabrodin, Lectures on nonlinear integrable equations and their solutions	

8. Facilities

9. Additional Notes