Skoltech

Course Syllabus

Course Title	Methods of Conformal Field Theory for Quantum Field Theory and String Theory
Course Title (in Russian)	Методы конформной теории поля в квантовой теории поля и теории струн
Lead Instructor	Litvinov, Alexey

1. Annotation

Course Description

The course is for students familiar with the basic concepts and methods of two-dimensional conformal field theory. The first part of the course will be devoted to the study of Wess-Zumino models, current algebra representation theory, coset constructions, and the Drinfeld-Sokolov quantum reduction. In the second part, we will consider various applications. In particular, we will consider conformal perturbation theory and its applications to the study of renormalization group flows. We will also study integrable perturbations of conformal field theory and the associated integrable hierarchies of equations, in particular the KdV hierarchy.

Course Description (in Russian)

Курс рассчитан на студентов знаковым с основными понятиями и методами двумерной конформной теории поля. Первая часть курс будет посвящена исследованию моделей Весса-Зумино, теории представлений алгебры токов, косет конструкции и квантовой редукции Дринфельда-Соколова. Во второй части мы рассмотрим различные приложения. В частности, будет рассмотрена конформная теория возмущений и ее применения для исследования ренормгрупповых потоков. Мы также изучим интегрируемые возмущения конформной теории поля и связанные с этим интегрируемые иерархии уравнений, в частности иерархию КдВ.

2. Basic Information

Course Academic Level

MSc PhD

Number of ECTS credits

6

Course Prerequisites / Recommendations

Being familiar with basics of CFT

Type of Assessment

Graded

Mapping from grades to percentage:

A: 86

B: 76

C: 66

D: 56

E: 46

F: 0

Term

Multiterm (Term 3-4)

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

BSc Programs	Masters Programs	PhD Programs
	Mathematical and Theoretical Physics	Physics

Maximum Number of Students

	Maximum Number of Students
Overall:	30
Per Group (for seminars and labs):	30

3. Course Content

Topic	Summary of Topic	Contact Hours: Lectures	Contact Hours: Seminars	Contact Hours: Labs	Non-contact Hours: Student's Independent Study
WZW models and currents algebra	Basic intruduction to WZW models, representation theory of affine Lie algebras, including free-field representations, Wakimoto modules, theory of Knizhnik-Zamolodchikov equation, coset construction, quantum Drinfeld-Sokolov reductions	20	20		41
CFT methods in field theory	Integrable field theory from conformal field theory, quantum KdV and related systems, conformal perturbation theory, CFT and RG, c-theorem	20	20		41

4. Learning Outcomes

Skoltech Learning Outcomes are indicated as per Skoltech Learning Outcomes Framework.

1. FUNDAMENTAL KNOWLEDGE

1.1. KNOWLEDGE OF MATHEMATICS AND NATURAL SCIENCES

2.1. COGNITION AND MODES OF REASONING

2.1.1. Analytical reasoning and problem solving

2.1.3. Creative thinking

2.2. ATTITUDES AND LEARNING PROCESS

2.2.1. Initiative and the willingness to take appropriate risks

2.2.3. Responsibility, intensity, perseverance, urgency and will to deliver

2.2.5. Self-awareness and a commitment to self-improvement, lifelong learning and educating

3.1. COMMUNICATIONS IN INTERNATIONAL ENVIRONMENTS

3.1.3. Oral presentation and discussion

3.1.4. Inquiry, listening and dialogue

5. Assignments and Grading

Physical Attendance Requirement (% of classes) 50

Assignment Type	Assignment Summary	% of Final Course Grade
Final Exam	Answers to questions on course lectures. Be able to solve any problem from homework in the presence of the lecturer.	50

Assignment Type	Assignment Summary	% of Final Course Grade
Problem Set	Submit solutions to most of the course homework assignments before the exam.	50

6. Assessment Criteria

Assignment 1 Type Final Exam

Sample of Assignment 1

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Assessment Criteria for Assignment 1

Understand and be able to work with the basic constructions described in the course. Know the basic definitions and theorems. Be able to solve problems similar to those discussed in the seminars.

Assignment 2 Type Problem Set

Assessment Criteria for Assignment 2

Typically, 80 percent of problems solved correctly guarantees a maximum grade.

7. Textbooks and Internet Resources

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

Required Textbooks	ISBN-13 (or ISBN-10)
Conformal field theory, P. Di Francesco, P. Mathieu, D. Senegal, Graduate texts in contemporary physics	

Web-resources (links)	Description
https://strings.itp.ac.ru/Lecture-Notes/CFT.pdf	lecture notes will be posted here

8. Facilities

Software
Wolfram Mathematica, Maple

Labs for Education

Laboratory of integrable systems and turbulence

NRU HSE-Skoltech International Laboratory of Representation Theory and Mathematical Physics

9. Additional Notes

The proposed course 1) has explicit academic content and requirements for receiving credits,

2) is in alignment with the program's learning outcomes, 3) adheres to policies and Skoltech regulations.

Lead Instructor confirms