MATH 663

Topics in Applied Mathematics

Instructor: Michael Gekhtman

A fascinating aspect of the theory of integrable (soliton) ODEs and PDEs is that they describe a wide variety of important models in physics, biology and engineering, while their conceptual study requires application of the most advanced tools of pure mathematics. In turn, integrable models originally used in applied mathematics, prove to be relevant and useful in differential and algebraic geometry, representation theory, etc.

This course will be centered on one of the most important examples of these interrelations, the celebrated Kadomtsev-Petviashvili (KP) equation, which can be reduced to many other integrable equations. We'll discuss alternative approaches to this equation, based on the algebra of pseudo-differential operators on the one hand and loop groups and infinite-dimensional Grassmanian on the other. The ultimate goal of the course is to present one of the most striking applications of soliton equations, Mulase's proof of Novikov's conjecture: The KP equation, discovered in 1970 in plasma physics, can be used to give an answer to the one hundred years old Schottky problem of singling out Jacobians of compact complex curves among all complex tori.

All background material that falls outside the scope of basic courses in analysis, ODEs and linear algebra, will be covered in class.