

Course Outline - Knots and Physics - CO 739

University of Waterloo, Winter Semester 2004

Times: Tues, Thurs 11:30 to 1:00

Place: MC5045.

Instructor - Louis H. Kauffman, UIC, UW, PI

<kauffman@uic.edu>

<http://www.math.uic.edu/~kauffman>

Description:

This course will introduce the basics of knot theory, and then concentrate on relationships of knot theory with physics. The course can be taken as a continuation of the fall term course PM 766 (Fall 2003), but that course is not a prerequisite. This course will start from the beginning but will develop different material from the fall course. The prerequisites are basic abstract algebra and a familiarity with the rudiments of point set topology.

Topics:

A. Basic Knot Theory.

Reidemeister moves, bracket polynomial, interpretation of bracket polynomial in terms of statistical mechanics and the Potts model.

B. Knot invariants constructed from solutions to the Yang-Baxter equation and from Hopf algebras (aka quantum groups).

C. Vassiliev Invariants and construction of knot invariants from Lie algebras.

D. Gauge Theory and the construction of knot invariants using the heuristics of functional integrals. Kontsevich integrals and knot invariants.

E. Introduction to general relativity, Ashtekar variables and loop quantum gravity a la Smolin and Rovelli. Relationship of functional integral heuristics to quantum gravity.

F. Selected topics in topological quantum field theory.

Suggested Texts

1. Louis H. Kauffman, "Knots and Physics", World Scientific, Third edition (2002).

2. John Baez and Javier P. Munain, "Gauge Fields, Knots and Gravity", World Scientific (1994).

3. <www.arxiv.org>