第5回「計算機を用いた数学研究」GCOE セミナー

Friday, December 11 - Saturday, December 12, 2009
Room 110 (lectures) & 109 (Tea), Faculty of Science Building #3
Department of Mathematics, Kyoto University

Program

December 11 (Fri)

10:00-11:30
Ian M. Anderson (Utah State University)
Symbolic Methods For Differential Geometry and its Applications
Lecture 1: An Introduction to Differential Geometry with Maple

13:30-15:00
Takashi Sakai (Tokyo Metropolitan University)
Minimal surfaces with 3D-XplorMath and Maple

15:30-17:00
Ian M. Anderson (Utah State University)
Symbolic Methods For Differential Geometry and its Applications
Lecture 2: An Introduction to Lie Algebras and Lie Groups with Maple

December 12 (Sat)

10:00-11:30
Ian M. Anderson (Utah State University)
Symbolic Methods For Differential Geometry and its Applications
Lecture 3: Applications to Differential Equations

13:30-15:00
M. Guest (Tokyo Metropolitan University)
Some constant mean curvature surfaces with 3D-XplorMath and Maple

15:30-17:00
Ian M. Anderson (Utah State University)
Symbolic Methods For Differential Geometry and its Applications
Lecture 4: Applications to the Calculus of Variations

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Abstract

Series Lecture — **Ian M. Anderson (Utah State University)**
Symbolic Methods For Differential Geometry and its Applications

Computer algebra systems such as Maple and Mathematica play an every increasingly important role in mathematics teaching and research across a broad range of disciplines. In this series of lectures, I shall discuss the use of Maple in the area of differential geometry and its applications to differential equations, the calculus of variations and mathematical physics. The format for each lecture will be the same - we shall review the relevant mathematical concepts and then illustrate these concepts using the *Differential Geometry* software package. Some details of various algorithms will be presented and on-going developments and open problems will be discussed. The software demonstrations will be made available to all conference participants. (Participants may wish to bring their laptops (with Maple - Release 11 or higher) but this is not required.)

December 11 (Fri)

10:00-11:30 **Lecture 1: An Introduction to Differential Geometry with Maple**

1. A brief introduction to the computer algebra system Maple. 2. An overview of the *Differential Geometry* software project. 3. Vector Fields, Flows and Brackets. 4. Invariants. 5. Differential Forms and Tensors. 6. Killing Vectors. 7. Symmetries of Differential Equations.

15:30-17:00 **Lecture 2: An Introduction to Lie Algebras and Lie Groups with Maple**

1. The Structure theory for Lie algebras -- Historical Remarks. 2. The *Differential Geometry* database of Lie algebras. 3. The Fundamental Theorems of Lie. 4. Classification Problems. 5. Application to the Equivalence Problem in General Relativity

December 12 (Sat)

10:00-11:30 **Lecture 3: Applications to Differential Equations**

1. Distributions and Pfaffian Systems. 2. Integral Manifolds. 3. External and Internal Geometries. 4. Using Lie groups to solve differential equations I. 5. Using Lie groups to solve differential equations II.

15:30-17:00 **Lecture 4: Applications to the Calculus of Variations**

1. Euler-Lagrange Operators. 2. Jet Spaces. 3. The Inverse problem of the Calculus of Variations. 4. The Principle of Symmetric Criticality.

December 11 (Fri) 13:30-15:00 — **Takashi Sakai (Tokyo Metropolitan University)**
Minimal surfaces with 3D-XplorMath and Maple

Abstract: In recent years, the mathematical visualization became familiar as the computer technology has developed. In this talk, first I would like to introduce a free software 3D-XplorMath, which is established by R. Palais and his team. 3D-XplorMath consists of several gallaries related to subjects of mathematics. One of the most developed gallary is Surface Gallary. The surface theory has developed explosively with the technology of computer graphics. I would like to explain the construction of minimal surfaces from holomorphic potential (Weierstrass-Enneper representation formula), and the method to create graphics of minimal surfaces using 3D-XplorMath and Maple.

December 12 (Sat) 13:30-15:00 — **Martin Guest (Tokyo Metropolitan University)**
Some constant mean curvature surfaces with 3D-XplorMath and Maple

Abstract: Surface theory is well-suited to mathematical visualization. Many surfaces have been beautifully constructed (and even discovered) in computer experiments with various kinds of software over the years. However, in some cases, it can be difficult to see "global aspects", either because of technical limitations or because of extreme sensitivity to initial data. Minimal surfaces are such a case. For example, nontrivial examples were constructed by Herman Karcher and Richard Palais using the software 3D-XplorMath, which will be described in the lecture by Takashi Sakai. We shall explain some of the difficulties which arise in constructing surfaces of constant mean curvature (CMC surfaces).