Mathematics 6332 (Spring 2020): Geometric Mechanics

Instructor: Dmitri Pavlov, Assistant Professor
Lectures: TuTh 11–12:30, MA 17
Credit hours: 3
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1 Course Outline

This course will teach the basics of geometric mechanics, understood in the broadest possible sense, including classical mechanics, quantum mechanics, and quantum field theory.

A classical array of topics will be covered, including the following: jets and differential operators; variational bicomplex; G-structures, Cartan geometry, and Spencer cohomology; sheaf cohomology, de Rham cohomology, Dolbeault cohomology, and derived stacks; gauge theory; symplectic and Lagrangian reduction.

The exposition will be heavily geometric, and connections to physics will be strongly emphasized.

2 Catalog Course Description

Geometric concepts in classical mechanics; Euler-Language equations, Legendre transform and Hamilton's equations; symplectic manifolds; group actions; momentum maps; Hamiltonian and Lagrangian reduction.

3 Course Specific Expected Learning Outcomes

Upon completion of this course, students will be able to apply geometric mechanics to their area of research.

4 Assessment of Expected Learning Outcomes

Homework assignments may be given throughout the course. Students may also elect to do a project (a 10-page paper and a 1-hour oral presentation) on a topic relevant to the subject matter. Midterms and a final may be administered in class or as 4-hour take-home exams.

5 Grading

The final grade depends on the homework, projects, midterms, and final exam, if any of these were administered.

6 Text

The material will be drawn from a variety of sources, individual texts will be indicated as the course progresses.

Some recommended texts include the following:

Néstor León Delgado: Lagrangian field theories: ind/pro-approach and L_∞-algebra of local observables. https://arxiv.org/abs/1805.10317

Ian M. Anderson: The Variational Bicomplex.
https://csclub.uwaterloo.ca/∼pbarfuss/TheVariationalBicomplex.pdf

Ian M. Anderson: Introduction to the variational bicomplex.
https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1170&context=mathsci_facpub

Urs Schreiber: Geometry of physics

Mark J. D. Hamilton: Mathematical Gauge Theory

Jet Nestruev: Smooth Manifolds and Observables

A. M. Vinogradov: Cohomological Analysis of Partial Differential Equations and Secondary Calculus

7 Schedule

There will be 28 class meetings on the following days:

January 16
January 21
January 23
January 28
January 30
February 4
February 6
February 11
February 13
February 18
February 20
February 25
February 27
March 3
March 5
March 10
March 12
March 24
March 26
March 31
April 2
April 7
April 9
April 14
April 16
April 21
April 23
April 28
April 30
May 5

8 Operating Policy 34.19: Student absence for observance of religious holy day

1. "Religious holy day" means a holy day observed by a religion whose places of worship are exempt from property taxation under Texas Tax Code §11.20.
2. A student who intends to observe a religious holy day should make that intention known in writing to the instructor prior to the absence. A student who is absent from classes for the observance of a religious holy day shall be allowed to take an examination or complete an assignment scheduled for that day within a reasonable time after the absence.
3. A student who is excused under section 2 may not be penalized for the absence; however, the instructor may respond appropriately if the student fails to complete the assignment satisfactorily.

9 Operating Policy 34.22(2b): Reasonable accommodation for students with disabilities

Any student who, because of a disability, may require special arrangements in order to meet the course requirements should contact the instructor as soon as possible to make any necessary arrangements. Students should present appropriate verification from Student Disability Services during the instructor's office hours. Please note: instructors are not allowed to provide classroom accommodations to a student until appropriate verification from Student Disability Services has been provided. For additional information, please contact Student Disability Services in West Hall or call 806–742–2405.

10 Operating Policy 34.12(5): Academic dishonesty definitions

Students must understand the principles of academic integrity, and abide by them in all class and/or course work at the University. Academic Misconduct violations are outlined Part I, section B.1 of the Code of Student Conduct. If there are questions of interpretation of academic integrity policies or about what might constitute an academic integrity violation, students are responsible for seeking guidance from the faculty member teaching the course in question.

Academic misconduct includes cheating, plagiarism, collusion, falsifying academic records, misrepresenting facts, violations of published professional ethics/standards, and any act or attempted act designed to give unfair academic advantage to oneself or another student. Additional information about academic misconduct is available in the Texas Tech University Handbook in Part II, section B of the Community Policies section in the Student Handbook at http://www.depts.ttu.edu/dos/handbook/.