COURSE ANNOUNCEMENT
Mathematics 5757 (Spring 2019)

Course Name: Modern Mathematical Methods in Relativity Theory II (a.k.a. "Applied Differential Geometry II")

Class Number: 33188 (grad); 33189 (ugrad)

Time and Place: Spring 2019: MWF 3:00-3:55pm; Enarson Classroom Bldg 226

Credits: 3 per semester

Prerequisites:
- Fundamentals of post-WWII Riemannian geometry: (i) difference between a covector and a vector, (ii) commutator of two vector fields, (iii) covariant derivative, (iv) exterior derivative
- A mature *attitude* towards mathematics and physics.

Audience: Mature undergraduate and graduate

Textbooks:
(a) *GRAVITATION* by C. W. Misner, K. S. Thorne, and J. A. Wheeler.
(b) Selections from *A JOURNEY INTO GRAVITY AND SPACETIME* by J.A. Wheeler

Benefits, Goal and Purpose: Develop *from the bottom up* the universal laws of nature in terms of fundamental non-trivial mathematics.

Agenda:
a) Assimilate the "track II" mathematical chapters of our primary text ("*GRAVITATION*" by MTW, see references above; this text exists on the internet) in order to integrate modern mathematics with the spacetime formulation of the laws of physics. Thus the development will focus on
   (1) the underlying differential geometric framework of spacetime, and
   (2) the formulation of its properties as they arise from classical mechanics, fluid dynamics, and wave mechanics.
b) Show why and how mathematics necessarily is the language of physical science, in particular of those aspects of physics dealing with processes of extreme violence (relativistic hydrodynamics, relativistic laser-matter interaction, high energy density physics, gravitational collapse in flat or curved spacetimes).

Website: `https://people.math.osu.edu/gerlach.1/math5756`

DESCRIPTION

Math 5757 (Spring):
- Galileo, Newton, Lagrange, Einstein
- Relativistic Lagrangian mechanics
- Geometric formulation of particle mechanics
- Density-flow of charge, momentum, and energy

- The conservation laws via scalar and vector valued exterior 3-forms
- Momentum-energy tensor: relativistic fluid equations of motion
- The Cartan-Wheeler formulation of Einstein's field equations: moment of rotation $= 8\pi G\times$ momentum-energy;
- The conservation laws and the Bianchi identities mathematized in terms of the "Boundary of a Boundary is zero $(\partial\,\partial\,\Omega = 0)$" principle.
- Extreme astrophysical entities mathematized by Einstein's field equations;
- Hamilton-Jacobi mechanics for relativistic particle orbits;
- Geometry of a black hole and the universe: local and global;
- vector harmonics, tensor harmonics, acoustic and gravitational waves in violent relativistic backgrounds.

Questions or comments are welcomed.

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