Physics 231: **Methods of Theoretical Physics**

Instructor:	Flip Tanedo	Room:	Physics 2111
Contact:	flip.tanedo@ucr.edu	Lecture:	MWF 10:10am – 11:00am
Office:	Physics 3054	Office Hour:	M 3:10pm – 4:00pm

Official Course Description

> Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): graduate standing or consent of instructor. A study of analytic functions, Cauchys theorem, Taylor series, Laurent series expansions, the residue theorem, and analytic continuation.

Unofficial Course Description

This is a crash course in mathematical methods in physics and their applications. The course covers a range of topics that will either be useful in your graduate coursework and research or are topics that every physicist should know something about. Rather than being deep and general, the course is broad and applied: this is not a mathematics course, this is *boot camp* for physicists.

Evaluation

Weekly homework assignments including finals week. No exams. I expect you to work together and to abide by the UCR academic integrity policies.

Textbook

The course textbook is *Mathematics for Physics: A Guided Tour for Graduate Students* (isbn 9780521854030) by Stone and Goldbart. No particular edition is required.

Feel free to also consult other references. Let me know if you find anything particularly useful.

Topics

I reserve the right to update this as necessary. Leftover weeks are for make-up lectures.

1. **Dimensional analysis** [1 day]. How to tell a physicist from a mathematician.
2. **Differential equations** [3 weeks]. Linear algebra review, functions as linear spaces, ordinary and partial differential equations, Green's functions, complex analysis review, contour integrals. This is the 'standard' math methods core, but focusing on the big picture. Physics: Review of quantum mechanics, tricks in 2D electrostatics, causality.
3. **Geometry**. [2 weeks] Vectors & dual vectors, metric spaces, calculus on manifolds, fiber bundles, introduction to cohomology. Physics: Special relativity, Maxwell's equations, geometry of phase space, magnetic monopoles, gauge theory of falling cats.
4. **Group theory**. [2 weeks] Introduction to the representations of Lie groups focusing on SU(N), introduction to the Poincaré group. Physics: introduction to unification, spinors.
5. **Practical statistics**. [1 week, if time permits] Uncertainties in measurements, likelihood and hypothesis testing, Bayesian vs. frequentist. Physics: when have you discovered something?