MAT 180 Topics
2018-2019 Academic Year

FALL QUARTER 2018: The Mathematics of Theoretical Physics (Prof. Andrew Waldron)

Theoretical physics provides a rubric to tie together many seemingly disparate pieces of mathematics typically learned by undergraduates. The course will reintroduce central notions from geometry, representation theory and algebra in the context of theories that describe the natural world, including general relativity, quantum mechanics and elementary quantum field theory. The course will be suitable for students with a strong grounding in calculus, linear algebra and differential equations and an interest in physics.

Course Outline:

1) Manifolds
2) What is a vector?
3) Grad, div and curl all over again — differential forms
4) Classical mechanics and one-forms
5) Connections — a first meeting
5) Quantum mechanics in a nutshell
6) Parallel transport and general relativity

Course grade:
The course grade is determined from a journal requirement—-Students must maintain a comprehensive journal that includes

i) Lecture notes reworked to reflect the student’s own understanding of material.
ii) Solutions to problems assigned in lectures.
iii) Literature summaries (brief summaries of relevant papers cited in class).

Students may work in teams on their journals so long as they submit their own work.

WINTER QUARTER 2019: Invitation to Classical Analysis (Prof. Naoki Saito)

This course explores classical and important topics in analysis that tend to be left out and neglected in modern curriculum of analysis (e.g., Rudin's book or MAT 127ABC) after students learned basic calculus (MAT 21 series). I plan to use a fantastic book of Peter Duren of the same title, which was published recently (2012) from AMS. Topics to be covered include: Inequalities; Approximation by Polynomials; Tauberian Theorems; the Gamma Function; Bernoulli Numbers and the Euler-Maclaurin Formula; Elliptic Integrals, etc. These will motivate many of our students who learned abstract concepts and techniques in calculus and analysis, yet are left wandering what to do with them.
Prerequisite: MAT 21 ABC.
SPRING QUARTER 2019: Introduction to Analytic Number Theory (Prof. Craig Tracy)

Prerequisites: MAT 185A (Complex Variables) or equivalent course.

Course Grade: 40% homework and 60% final exam.

Textbook: There is no required textbook for the course. Lecture notes will be distributed. A recommended reading list is posted on UC Davis Canvas. These recommended books are on reserve in Shields Library.

Course Outline:
2. Dirichlet series and arithmetical functions.
   a. Riemann zeta-function and Euler product formula.
   b. Analytic continuation of the Riemann zeta-function.
   c. Functional equation for the Riemann zeta-function.
   d. Zero-free theorem and zeta-function estimates.
   e. Perron’s formula.
3. Prime number theorem.
4. Partitions of integers
   a. Dedekind eta function
   b. Kronecker limit formula
5. Elliptic and modular functions
   a. Field of elliptic functions
   b. Weierstrass elliptic function $\wp(z)$.
   c. Eisenstein series
   d. Modular group, modular forms, and cusp forms. Dimension formulas
   e. Number theoretic consequences