
Abstract Algebra I
Instructor: Prof. William Heinzer
Course Number: MA 55700
Time: MWF 3:30pm

Description

I plan to cover material from the text *Introduction to Commutative Algebra* by M. F. Atiyah and I. G. Macdonald. In particular, the course will cover: Rings and Ideals, Modules, Rings and Modules of Fractions, Primary Decomposition, Integral Dependence and Valuations, Chain Conditions, Noetherian Rings, Artinian Rings, Discrete Valuation Rings and Dedekind Domains, Completions and Dimension Theory. I hope to encourage active student participation in the class by having students present in class exercises and/or selected material from the text.

The Radon Transform and Medical Imaging
Course Number: MA 59800
Instructor: Prof. Plamen Stefanov
Time: MWF 3:30pm

Description

This course is an introduction to some mathematical methods (general known as tomography) in medical imaging based on the Radon transform. The main text is a recent book by Peter Kuchment with the same title, supplemented with lecture notes posted on the web. We will start with an introduction to the X-ray transform and the Radon transform and their applications in Computed Tomography (CT), Single Photon Emission Tomography (SPECT) and Positron Emission Tomography (PET). Next, we will concentrate on recovery of singularities and problems with partial data. Finally, we will review the mathematics of Thermoacoustic Tomography (TAT) and Electric Impedance Tomography (EIT). Some familiarity with distributions and the Fourier Transform is desirable.

Required Texts: Peter Kuchmen, The Radon Transform and Medical Imaging

Optional Texts and References: http://www.math.purdue.edu/ stefanov/publications/book.pdf

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Differential Topology
Course Number: MA 59800
Instructor: Prof. R. Kaufmann
Time: TTh 9:00

Description

Differential topology is at the intersection of topology and analysis. One could say that the main aim is to derive topological data using differential calculus. This has the advantage that many notions become more intuitive. For instance one can discuss cohomology using deRham forms and make Poincaré duality explicit. One can also represent characteristic classes using forms. This can be of computational as well as of conceptual help.

We will use the classic text of Bott and Tu for the most part.

Introduction to the Basics of Complex Manifolds and Hodge Theory
Instructor: Prof. Kenji Matsuki
Course Number: MA 59800
Time: MWF 1:30pm

Description

The purpose of this course is to introduce the students to the basics of complex manifolds and to the fundamentals of the Hodge theory in an easy and accessible way.

We will follow closely the textbook by Claire Voisin titled "Hodge Theory and Complex Algebraic Geometry", supplemented by another textbook "Differential analysis on Complex Manifolds" by R.O. Wells, for this purpose.

Part I of Voisin's book gives a brief yet concise introduction to the basics of complex manifolds, including the discussion of the Kähler metrics and sheaf cohomology. Part II of the book discusses the celebrated Hodge decomposition for the cohomology of compact Kähler manifolds through harmonic analysis and the Hodge structures. These are the two parts that I can most likely cover in one semester, leaving Part III, variations of Hodge structure, unfortunately not discussed and left for future courses.

If a student does not have too much background for making himself comfortable with complex manifolds and if he feels a little overwhelmed by Voisin's book, then I recommend "Differential analysis on Complex Manifolds" by R.O. Wells for a side reading, where the presentation is more down-to-earth and probably easier for a beginner.

These two textbooks are quite well-written so that the students can read through them without any lecture of mine. My goal for the course, therefore, is to explain the main ideas through the lectures in order to give the students some clearer overview and global picture, which one may not be able to see at the first sight or which one might miss through a careful yet painful line-by-line proof-reading of the material when he starts learning the subject.

I will give several report problems along the way, and the final grade will be determined by the report submitted at the end of the semester.

Textbook:

- "Hodge Theory and Complex Algebraic Geometry" by Clair Voisin
- "Differential analysis on Complex Manifolds" by R.O. Wells

Prerequisites:

- some basic knowledge of complex analysis of one variable (or preferably of several variables),
- some basic knowledge of general topology,
- some basic knowledge of homological algebra, and
- the willingness to work hard :) (the most important prerequisite)

Methods of Linear and Nonlinear Partial Differential Equations I
Course Number: MA64200
Instructor: Arshak Petrosyan

Time: MWF 11:30am

Description

This is the first semester in a one-year course on the theory of PDEs. The Fall semester focuses on linear second order elliptic equations. Topics to be covered include Laplace?s equation, the maximum principle, Poisson?s equation and the Newtonian potential, Schauder?s estimates for classical solutions, Sobolev Spaces, weak solutions and their regularity.

Required Texts: D. Gilbarg, N. S. Trudinger, Elliptic partial differential equations of second order. Second edition.

Commutative Algebra
Instructor: Prof. Bernd Ulrich
Course Number: MA 65000
Time: MWF 3:30pm

Description

This is an intermediate level course in commutative algebra. It is a continuation of MA 557/558, but should be accessible to anybody with basic knowledge in commutative algebra (localization, Noetherian and Artinian modules, associated primes and primary decomposition, integral extensions, dimension theory, completion, Ext and Tor). The topics of this semester will include: Graded rings and modules, depth and Cohen-Macaulayness, structure of finite free resolutions, regular rings and normal rings, canonical modules and Gorenstein rings, local cohomology and local duality. Prerequisites: Basic knowledge of commutative algebra (such as the material of MA 557/558).

Optional Texts and References: No specific text will be used, but possible references are: - H. Matsumura, Commutative ring theory, Cambridge University Press - W. Bruns and J. Herzog, Cohen-Macaulay rings, Cambridge University Press - D. Eisenbud, Commutative algebra with a view toward algebraic geometry, Springer.

CLASS FIELD THEORY
Instructor: Prof. Freydoon Shahidi
Course Number: MA 68400
Time: MWF 9:30am

Description

Class Field Theory is the crowning achievement of number theory in the first half of the 20th century. It provides a one-one correspondence between abelian extensions of local and global fields by means of subgroups of certain locally compact groups defined by the completions of the base field (ideles, adeles). It is the generalization of this idea to non-abelian extensions which led Langlands to propose his ground breaking conjectures which is now generally addressed as the Langlands Program. Here is the outline of what will be covered: Adeles, ideles, Hecke's abelian L-functions, first and seconed inequalities of class field theory, Artin symbol, reciprocity, local and global class fields, Kronecker-Weber Theorem. I will prove the first inequality using L-functions which is still one of the most beautiful applications of analysis to number theory. More abstract proofs, which came fairly later, use cohomology which is the main tool in proving the second inequality.

Optional Texts and References: 1. S. Lang, Algebraic Number Theory 2. Cassels and Frohlich, Algebraic Number Theory 3. J. Neukirch, Class Field Theory

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Gröbner Bases in Commutative Algebra
Instructor: Prof. Giulio Caviglia
Course Number: MA 69000
Time: TTh 3:00pm

Description

The goal of this class is to give an introduction to Gröbner basis theory and its applications to problems in commutative algebra. I will follow quite closely the outline of the book: Gröbner bases in Commutative Algebra by Ene and Herzog.

This course should be accessible to anybody with basic knowledge in commutative and homological algebra.

Optional Texts and References: 1. Ene and Herzog, Gröbner bases in Commutative Algebra. 2. Eisenbud, Commutative Algebra. 3. Sturmfels, Gröbner bases and convex polytopes.

Mathematical Biology
Instructor: Prof. Julie Feng
Course Number: MA 69200
Time: TTh 3:00pm

Description

This is a special topic course in mathematical biology. It focuses on applications of mathematical methods and concepts to the description and analysis of biological processes. The mathematical contents consist of difference and differential equations and elements of stochastic process. The topics to be covered include dynamical systems theory motivated in terms of its relationship to biological theory, deterministic models of population processes, epidemiology, coevolutionary systems, structured population models, nonlinear dynamics, and stochastic simulations. Research papers on these topic will be discussed and some of the mathematical theory and tools used in analyzing these models will be reviewed. Students will have opportunities to present their research work and bio-mathematical research projects (in small group) may be carried out.

TOPICS IN COMPLEX GEOMETRY

Instructor: Prof. Sai-Kee Yeung (yeung@math.purdue.edu, 4-41942)

Course Number: MA69600 CRN: 63580

Credits: Three

Time: 11:30 a.m.–12:30 p.m. MWF

Description

Prerequisite: 562, 525

1. Introduction to Kaehler geometry.

2. Introduction to symmetric spaces.

3. Introduction to heat equations, harmonic maps and rigidity.

4. Introduction to K"ahler-Ricci flow.

5. Introduction to topics in diophantine geometry, such as Roth's Theorem and Vojta's proof of Faltings' Theorem.

Text: The lecturer would provide reference as the class proceeds.