Courses and Seminars of Interest to Graduate Students
offered by the
Mathematics Department
Spring, 2006

MA 490C (crosslisted with BIOL 595N): Mathematical models of cardiac electrical activity
Instructor: Prof. Buzzard, office: Math 702, phone: 49–41937, e-mail: buzzard@math.purdue.edu
Time: MA 490C, MWF 10:30; BIOL 595N, MW 10:30, plus one additional hour to be arranged.
Prerequisite: MA 366, Differential Equations (Math section only); BIOL 595N, Two semesters of Calculus, such as MA 223 and 224, or MA 161 and 162 (Biology section only)
Description: This course will be devoted to understanding the basics of electrical activity in the heart at three different levels: ion channels, single cell, and fibers. We will discuss some of the basic biology involved in the functioning of each of these levels and discuss possible mathematical models for each. The main mathematical tools will be ordinary differential equations, although there will be a brief introduction to partial differential equations for the fiber description. We will consider these models both from a theoretical and a computational point of view. A major component of the class will be a group project focused on creating and understanding a compuational model of a cardiac system. Students will be required to use some compuational package such as matlab, and there will be some group projects.
Texts: BIOL 595N and MATH 490C will both use *Computational Cell Biology*, by C. P. Fall, E. S. Marland, J. M. Wagner, and J. J. Tyson, editors, 2002.
In addition, MATH 490C will use *Non-linear Dynamics and Chaos*, by S. H. Strogatz, 1994.

MA 546: Introduction to Functional Analysis
Instructor: Prof. Dadarlat, office: Math 708, phone: 49–41940, e-mail: mdd@math.purdue.edu
Time: MWF 1:30
Prerequisite: MA 544
Description: Banach spaces and Hilbert spaces; weak topologies; Hahn-Banach theorem; principle of uniform boundedness; open mapping theorem; Krein-Milman theorem and applications (including Stone-Weierstrass theorem). Operators on Hilbert spaces; spectral theorem for hermitian operators; Compact operators; Peter-Weyl theorem. Depending on the interest of the students, I plan to discuss additional topics related to group representations, operator algebras and/or PDEs.

The grade will be based on homework (70%) and a take home final exam (30%).
References: Most topics are covered by J. B. Conway's book, *A Course in Functional Analysis*, which is recommended.

MA 558: Abstract Algebra II
Instructor: Prof. Ulrich, office: Math 618, phone: 49–41972, e-mail: ulrich@math.purdue.edu
Time: MWF 2:30
Prerequisite: Basic knowledge about commutative rings (such as the material of MA 557).
Description: The topics of the course will be introductory homological algebra and commutative algebra. We will study properties of commutative rings and their modules, with some emphasis on homological methods. The course should be particularly useful to students interested in commutative algebra, algebraic geometry, number theory or algebraic topology. Specific topics are: Derived functors, structure of injective modules, flatness, completion, dimension theory, regular sequences, Cohen-Macaulay modules.
Text: No particular book is required, but typical texts are:
- J. Rotman, *An introduction to homological algebra*, Academic Press.
- H. Matsumura, *Commutative ring theory*, Cambridge.
- W. Bruns and J. Herzog, *Cohen-Macaulay rings*, Cambridge.
- D. Eisenbud, *Commutative algebra with a view toward algebraic geometry*, Springer.

MA 598B: Spatial Statistics and Stochastic Processes in Geophysics(meets with EAS 591F)
Instructor: Prof. Cushman, office: Math 816, phone: 49–48040, e-mail: jcushman@math.purdue.edu
Time: TTh 12:00-1:15
Description: The first half of the course will focus on best linear estimation methods for sets of spatially distributed data that arise in geophysical applications (geostatistics, cf. Kitanidis Intro to Geostatistics, Cambridge, 1997). The latter half of the course will focus on employing geostatistics with the underlying physical/chemical/morphological laws to provide more robust nonlinear estimators (cf. Cushman, *The Physics of Fluids in Hierarchical Porous Media: Angstroms to Miles*, Kluwer, 1997). An elementary background in probability is a prerequisite.

MA 598E: Complex Analysis
Instructor: Prof. de Branges, office: Math 800, phone: 49–46057, e-mail: `branges@math.purdue.edu`
Time: MWF 9:30
Description: An introductory course in complex analysis is offered which includes techniques introduced in the second half of the twentieth century while retaining a relationship to number theory which existed in the first half of the century. The course is however not aimed a preparing students for qualifying examinations in complex analysis but presumes a level of mathematical maturity which these examinations test. A treatment of topology, not only in the plane, but also on Riemann surfaces, is derived from the use of convexity. A proof of the Hahn–Banach theorem is given using the Zorn lemma. Students are expected to be acquainted with the algebra of polynomials with rational coefficients and its quotient fields. Analytic function theory is approached as a theory of square summable power series. The factorization of functions which are analytic and bounded by one in the unit disk is presented as a determination of invariant subspaces of transformations. Hilbert spaces are introduced whose elements are functions analytic in the unit disk. Reproducing kernel functions and complementation theory are used to determine the structure of such spaces. A proof of the maximum principle is given from Rolle's theorem. An application of the maximum principle is used to show that a function which is differentiable and bounded in the unit disk is represented by a square summable power series. Another application is the Poisson representation of a function which is analytic and has nonnegative real part in the unit disk. The Riemann mapping theorem is obtained by an explicit construction for convex subregions of the complex plane. An estimation theory for mapping functions is an application of the Radon transformation, as it is also applied in the proof of the Riemann hypothesis. A proof of the Bieberbach conjecture is obtained using the Löwner parameterization of mappings.

MA 598F: Numerical Modeling and Inversion in Porous Media
Instructor: Prof. Santos, office: Math 808, e-mail: `santos@math.purdue.edu`
Time: TTh 3:00-4:15
Description: Derivation of the static and dynamic behavior of fluid-saturated porous media using phenomenological and homogenization approaches. Constitutive relations, Darcy's law, Biot's equations of motion. Plane wave analysis.

Flow in porous media, Richard's equation for groundwater flow in variably saturated soils. Contaminant transport.

Review of the Finite Element Method. Description of some finite element spaces in 2D and 3D. Analysis of the interpolation error.

Numerical solution of the equations of motion in fluid-saturated porous media using the finite element method. Global and domain decomposed finite element algorithms. Parallel implementation. Numerical dispersion analysis. Applications to wave propagation in partially frozen porous media. Computer implementation.

Numerical solution of Richard's equation for groundwater flow using finite element methods. Application to simulate groundwater flow in highly heterogeneous soils. Computer implementation.

Parameter estimation in systems described by partial differential equations using functional optimization techniques. The Gateaux (directional) derivative. Variational formulation. The adjoint method.

Application of optimization techniques to the estimation of wave speeds, permeabilities and other parameters in layered media combining the finite element method with Newton-type iterations. Analysis of the convergence of the estimation procedures. Computer implementation.

References:
1. W. A. Jury, W. R. Gardner and W. H. Gardner, *Soil Physics*, J. Wyley, New York, 1991.
2. P. G. Ciarlet, *The Finite Element Method for Elliptic Problems*, North-Holland, 1980.
3. S. C. Brenner and L. R. Scott, *The Mathematical Theory of Finite Element Methods*, Springer, New York, 1994. 4. E. B. Becker, G. F. Carey and J. T. Oden, *Finite Elements, an Introduction, Volume I*, Prentice Hall, 1981.
5. G. F. Carey and J. T. Oden, *Finite Elements, a Second Course*, Prentice Hall, 1983.
6. H. T. Banks and K. Kunish, *Estimation Techniques for Distributed Parameter Systems*, Birkhauser, Boston, 1989.
7. A. Tarantola, *Inverse Problem Theory*, Elsevier, New York, 1987.
8. J. Nocedal and S. Wright, *Numerical Optimization*, Springer, New York, 1999.
9. E. Sanchez-Palencia, *Non-Homogeneous Media and Vibration Theory*, Springer, New York, 1980.
10. J. E. Santos *Introduction to the Theory of Poroelasticity*, Technical Report #321, October 1998, Center for Applied Mathematics, Purdue University.
11.E. M. Fernández Berdaguer, J. E. Santos and D. Sheen, *An iterative procedure for estimation of variable coefficients in a hyperbolic system*, Applied Mathematics and Computation, 76 (1996) 210–250.
12. L. Guarracino and J. E. Santos *Stochastic modeling of variably saturated flow in fractal porous media*, Mathematical Geology, 36 (2), 2004, 239–260.
13. J. E. Santos, C. L. Ravazzoli and J. M. Carcione, *A model for wave propagation in a composite solid matrix saturated by a single-phase fluid*, Journal of the Acoustical Society of America, 115 (6), 2004, 2749-2760.
14. J. E. Santos, C. L. Ravazzoli and J. Geiser, *On the static and dynamic behavior of fluid saturated composite porous solids; a homogenization approach*, Technical Report Series ISC-04-11-MATH, Institute for Scientific Computation, Texas A&M University, to appear in International Journal of Solids and Structures, 2005.
15. J. E. Santos, Y. Efendiev and L. Guarracino, *Permeability estimation in variable saturated soils using the adjoint method*, Technical Report Series ISC-05-05-MATH, Institute for Scientific Computation, Texas A&M University, submitted to Computer Methods in Applied Mechanics and Engineering.

MA 598M: Basic Algebraic Geometry II
Instructor: Prof. Abhyankar, office: Math 600, phone: 49–41933, e-mail: `ram@math.purdue.edu`
Time: TTh 1:30-2:45 (THE MEETING OF CLASSES WILL START ON JANUARY 31
Description: This will be an introduction to algebraic geometry. There are no prerequisites and all interested students are welcome. Although in some sense this is a continuation of the Fall 2005 course MA 598G, we shall make a fresh start. There will be several extra help sessions organized for beginning students. Here are descriptions of possible topics to be covered.

• ANALYSIS AND RESOLUTION OF SINGULARITIES OF PLANE CURVES: A plane curve C of degree n is given by a polynomial equation $F(X,Y)=0$ of degree n. By translation of coordinates, any point P of C can be brought to the origin $(0,0)$. Now $F=F_d+F_{d+1}+\cdots+F_n$ where F_i is homogeneous of degree i with $F_d \neq 0 \neq F_n$. P is a simple point of C means $d=1$; otherwise it is a multiple point of multiplicity d. The distinct factors of F_d, say h of them, are the tangents to C at P. Applying a QDT = Quadratic Transformation centered at P amounts to substituting $X=X'$ and $Y=X'Y'$ to get $F(X',X'Y')=X'^dF'(X',Y')$. This explodes P into points $P'_1,\dots,P'_h$ of the proper transform $C': F'=0$ of multiplicities $d'_1,\dots.d'_h$ with $d'_1+\cdots+d'_h \leq d$. These are points in the first neighborhood of P. Iterating this we get points in the second neighborhood, and so on. Collectively they are point infinitely near to P. Let $\delta(P)=\sum\frac{\mu(Q)(\mu(Q)-1)}{2}$ where $\mu(Q)$ is the multiplicity at Q and the summation over all points Q infinitely near to P. Assuming C to be devoid of multiple components, Max Noether (1875) proved $\delta(P)<\infty$. Dedekind (1882) proved $\delta(P)$ to be length of the conductor of the local ring of P on C. Assuming C to be irreducible he showed $g(C)=\frac{n(n-1)}{2}-\sum\delta(P)$ where the sum is over all singular (= nonsimple) points P of C and $g(C)$ is the genus of C defined by Jacobi (1830) to be the number of independent regular differentials on C.

• HIGHER DIMENSIONAL DESINGULARIZATION. Extending QDTs to spaces of higher dimension we get MDTs = Monoidal Transformations. Zariski (1939-1944) in characteristic 0 and Abhyankar (1954-1965) in characteristic $p \neq 0$ showed that by using MDTs, the Noether procedure can be generalized to varieties of dimension 2 and 3. Hironaka (1964) extended this to characteristic 0 and any dimension. Abhyankar (1963) did it in the "arithmetic case" for dimension 2. We shall explore the possibilities of generalizing all this to higher dimension for nonzero characteristic as well as for the arithmetic case.

• RATIONAL AND POLYNOMIAL PARAMETRIZATION. Curve genus formulas can be used to decide when a curve can be rationally parametrized or even polynomially parametrized. Corresponding surface genus formulas can be used in a similar, but much more complicated, manner.

• CALCULATION OF FUNDAMENTAL GROUPS. Genus formulas can be used for calculating fundamental groups. In case of nonzero characteristic, they have to be supplemented with the theory of finite simple groups.

Texts: (1) *Algebraic Geometry for Scientists and Engineers,* Shreeram S. Abhyankar, Published by Amer Math Soc.
(2) *Ramification Theoretic Methods in Algebraic Geometry,* Shreeram S. Abhyankar, Published by Princeton U. Press.

MA 598S: Group Actions and Algebraic Topology
Instructor: Prof. Wilkerson, office: Math 700, phone: 49–41955, e-mail: `wilker@math.purdue.edu`
Time: MWF 9:30
Description: The action of finite groups and compact Lie groups on manifolds and other finite dimensional topology spaces has a long history. As an example, for p a prime number :

Let G be a finite p-group acting on a finite CW complex X. Then the Euler characteristic of X and the fixed point set X^G are congruent mod p.

The class will begin with the work of the Borel Seminar (50's) on the foundations of Smith theory and proceed to the techniques needed to prove the Sullivan conjecture, which relates the algebraic topology of the fixed point set to that of an approximation, the homotopy fixed point set. One of tools used will be Steenrod algebra, which acts on the mod p cohomology of a topological space.

Text: (1) L. Schwartz *Notes*, University of Chicago Press.
(2) original references.

MA 598U/STAT 598W: Design and Analysis of Financial Algorithms
Instructor: Prof. Viens, office: Math 504, phone: 49–46035, e-mail: `viens@stat.purdue.edu`
Time: Arrange Hours
Prerequisite: The student must have a working knowledge in financial mathematics at the MS level, as provided for example by MGMT 641 or IE 590 A, and a prior knowledge of Excel, or should have passed MA 516/STAT 541. A basic knowledge of object-oriented programming prior to starting the course is helpful.
Description: Information technology (IT) has become a major function in the financial industry. The industry has been employing different software and programming languages to process and maintain the data, to price equity and fixed income derivatives and to predict the stock movement. With good programming skills, one can excel in his/her job performance. In this course, we expect to learn Excel VBA, C/C++, MATLAB and GAMS/CPLEX which are some of most useful programming tools in financial firms.

MA 611: Methods of Applied Mathematics I
Instructor: Prof. Danielli, office: Math 802, phone: 49–41920, e-mail: `danielli@math.purdue.edu`
Time: TTh 1:30-2:45
Prerequisite: MA 511, 544
Description: Banach spaces; linear operators; the Open Mapping Theorem and the Closed Graph Theorem; the Hahn-Banach Theorem; weak topologies; the Fredholm-Riesz-Schauder theory and elements of Spectral Theory for compact operators; Hilbert spaces; the Projection Theorem; the Riesz Theorem and the Lax-Milgram Lemma; self-adjoint operators. Applications to ordinary and partial differential equations.
Text: A. Friedman, *Foundations of Modern Analysis*, Dover
Additional recommended reference: Hl. Brezis *Analyse Functionnelle - Theorie et applications*, Masson.

MA 615 (meets with CS 615): Numerical Methods For Partial Differential Equations I
Instructor: Prof. Cai, office: Math 810, phone: 49–41921, e-mail: `zcai@math.purdue.edu`
Time: TTh 12:00-1:15
Prerequisite: MA 514, 523
Description: Finite element method for elliptic partial differential equations; weak formulation; finite-dimensional approximations; error bounds; algorithmic issues; solving sparse linear systems; finite element method for parabolic partial differential equations; backward difference and Crank-Nicholson time-stepping; introduction to finite difference methods for elliptic, parabolic, and hyperbolic equations; stability, consistency, and convergence; discrete maximum principles.
References: 1.) S. Brenner and R. Scott *The Mathematical Theory of Finite Element Methods*
2.) J. Strikwerda, *Finite Difference Schemes and Partial Differential Equations*

MA 631: Several Complex Variables
Instructor: Prof. Catlin, office: Math 744, phone: 49–41958, e-mail: `catlin@math.purdue.edu`
Time: MWF 11:30
Prerequisite: MA 530
Description: Holomorphic functions, Power series, representation by integrals, extension of functions, pseudoconvex domains, Hörmander weighted estimates for $\overline{\partial}$, Cousin problems, Weierstrass preparation theorme, local theory of analytic sets.
Text: Hörmander, *An Introduction to Complex Analysis in Several Variables*, Van Nostrand.

MA 643: Methods of Partial Differential Equations II
Instructor: Prof. Phillips, office: Math 706, phone: 49–41939, e-mail: `phillips@math.purdue.edu`
Time: MWF 2:30
Prerequisite: MA 642
Description: Continuation of MA 642. Topics to be covered are L_p theory for solutions of elliptic equations, including Moser's estimates, Aleksandrov maximum principle, and the Calderon-Zygmund theory. Introduction to evolution problems for parabolic and hyperbolic equations, including Galerkin approximation and semigroup methods. Applications to nonlinear problems.
References: L.C. Evans *Partial Differential Equations*
Text: D. Gilbarg and N.S. Trudinger*Elliptic Partial Differential Equations of Second Order*

MA 650: Commutative Algebra
Instructor: Prof. Heinzer, office: Math 636, phone: 49–41980, e-mail: `heinzer@math.purdue.edu`
Time: MWF 3:30
Prerequisite: MA 558
Description: I plan to cover material from the text *Commutative Ring Theory* by H. Matsumura. In particular, the course will cover: properties of extension rings, integral extensions, valuation rings, dimension theory of graded rings, the Hilbert function and Hilbert polynomial, systems of parameters and multiplicity, the dimension of extension rings, regular sequences and the Koszul complex, Cohen-Macaulay rings, Gorenstein rings, regular rings and UFDs.
Text: Matsumura *Commutative Ring Theory*, Cambridge University Press

MA 661: Modern Differential Geometry
Instructor: Prof. Donnelly, office: Math 716, phone: 49–41944, e-mail: `hgd@math.purdue.edu`
Time: MWF 9:30
Description: Introduction to Reimannian geometry. Levi–Civita connection and curvature tensor. Geodesics and Hopf–Rinow theorem. Expenential map and normal coordinates. Submanifolds and second fundamental form. First and second variation formula. Jacobi fields. Curvature and toplogy.
Text: John M. Lee, *Riemannian manifolds, An Introduction to Curvature.*

MA 665: Algebraic Geometry
Instructor: Prof. Arapura, office: Math 642, phone: 49–41983, e-mail: `dxb@math.purdue.edu`
Time: TTh 12:00-1:15
Description: Broadly speaking, algebraic geometry is the study of sets of solutions to polynomial equations. These solutions may be considered over the field of complex numbers, or over more general fields or rings. As you might guess, there are many connections to algebra, complex analysis, number theory, topology... I hope the course may be useful to people who plan to work in these areas. Some more information is on my class webpage http://www.math.purdue.edu/ dvb/algeom.html

Unfortunately, the path to understanding in the subject is strewn with a number of obstacles. You have to master a lot of technical material while simultaneously developing a geometric intuition. It's next to impossible to do all of this in a semester. So I'm going to draw the line through the middle, and concentrate on varieties rather than schemes and say nothing about sheaf cohomology. I'll try to keep the prerequisites to a minimum: Some commutative algebra, point set topology, and calculus (tangent planes and stuff like that).

MA 684: Class Field Theory
Instructor: Prof. Yu, office: Math 738, phone: 49–41946, e-mail: `jyu@math.purdue.edu`
Time: TTh 10:30-11:45
Prerequisite: MA 584 (algebraic number theory). Group cohomology and relevant facts from algebraic geometry will be covered as needed.
Description: Class field theory is the study of abelian extensions of local fields, number fields, and function fields. It is the crowning achievement of number theory in the early 20th century, and now a basic knowledge for any one working in number theory. As such, it admits diversed approaches and views, leading to different ramifications in modern number theory.

This semester we will do it in a way different from recent offerings of this course. Group cohomology will be used as a basic machinery, and more emphasis will be put in the function field case, where the proof is easier as one can utilize extra insights from algebraic geometry. We will also give the formulation of the number field case in the ideal theory language, but not the full proof. In additions to the main theorems, we may cover topics such as non–abelian L–functions, Chebotarev density theorem, constructions of class fields, and Tate's thesis.
Text: Serre, *Algebraic groups and class fields*, Springer-Verlag.

MA 690K: Arithmetic Theory of Fundamental Groups
Instructor: Prof. Kim, office: Math 748, phone: 49–43173, e-mail: `kimm@math.purdue.edu`
Time: TTh 3:00-4:15
Description: Much progress in number theory and algebraic geometry in the second half of the twentieth century was achieved using the *homological* view of algebraic and arithmetic geometry. The ideas there included various kinds of coherent sheaf cohomology, Hodge theory, and the cohomology of Grothendieck topologies.

In the meanwhile, towards the end of the century, it became increasingly clear that the incorporation of *homotopical* methods would be even more far-reaching in its applications. A notable example is the use of stable homotopy theory in Voevodsky's approach to motivic cohomology.

In this course, we will study arithmetic uses of homotopy from a different perspective, namely, that of the fundamental group. This approach confers to the subject a far more non-linear flavor than that of Voevodsky. We will start by reviewing Grothentieck's theory of the fundamental group (which subsumes classical Galois theory), move through the study of Galois actions on fundamental groups (Ihara's theory), briefly describe the motivic fundamental group studied by Deligne (touching on certain aspects of non-abelian Hodge theory and the function theory of multiple polylogarithms), and finish with the important topic of *anabelian geometry.* Here, the geometry of certain kinds of schemes will end up being completely encoded into their fundamental groups, in a manner reminiscent of hyperbolic geometry. A nice example of the kind of theorem we will discuss towards the end is the one of Neukirch and Uchida:

All automorphisms of Gal$(\bar{\mathbb{Q}}/\mathbb{Q})$ *are inner.*

In spite of all these words, the main ideas of the course should be accessible to students with a general background in algebra, geometry, and topology. In fact, a large part of the charm in this study is the seamless manner in which elementary lines of investigation can be woven into a continuous fabric of deep mathematics. Background reading will be assigned for the more technical portions.

MA 692B: Fourier Integral Operators
Instructor: Prof. Sá Barreto, office: Math 604, phone: 49–41965, e-mail: `sabarre@math.purdue.edu`
Time: MWF 1:30
Prerequisite: The student should have a good knowledge of the theory of distributions and be reasonably familiar with differential geometry (at least know that a manifold, a submanifold, the tangent and cotangent bundles, and vector fields are)
Description: The course will be an introduction to the theory of Fourier integral operators and its calculus. These kinds of operators, which are given by oscillatory integrals, appear in several areas of mathematics and physics, including geometrical optics and quantum mechanics. The definition of a Fourier integral operator is simply a precise mathematical formulation of quantization. Namely the correspondence between functions of domain and frequency variables, and operators acting on a Hilbert space.
References: 1.) J. Bruñing and V. Guillemain, *Fourier Integral Operators*, Springer Verlag
2.) J. J. Duistermaat, *Fourier Integral Operators*, Birkhäuser
3.) A. Grigis and J. Sjöstrand, *Microlocal Analysis of Differential Operators*, Campridge University Press.
4.) Lars Hörmander, *The Analysis of Linear Partial Differential Operators*, vols. 3 and 4, Springer Verlag.

MA 692F: Special Topics in Mathematical Epidemiology
Instructor: Prof. Feng, office: Math 814, phone: 49–41915, e-mail: `zfeng@math.purdue.edu`
Time: MWF 11:30
Description: This course focuses on the application of mathematical methods and concepts to the description and analysis of biological processes. Emphasis will be on mathematical approaches for the study of population dynamics in epidemiology. The mathematical contents consist of difference and differential equations and elements of stochastic processes. The topics to be covered include dynamical systems theory motivated in terms of its relationship to biological theory, deterministic models of epidemiology, coevolutionary systems, structured population models, stochastic processes, and introduction to Mathematica and MATLAB (computer packages). Bio-mathematical research projects (in small group) may be carried out.
References: (1) Brauer and Castillo-Chavez, *Mathematical Models in Population Biology and Epidemiology (optional)*
(2) Thieme *Mathematics in Population Biology (optional)*

MA 692T: Advanced Scientific Computing and Numerical Analysis
Instructor: Prof. Shen, office: Math 806, phone: 49–41923, e-mail: `shen@math.purdue.edu`
Time: TTh 9:00-10:15
Prerequisite: A good knowledge on the polynomial approximation results in Sobolev spaces and on the basic implementation of spectral methods
Description: A variety of scattered topics will be covered in this course. Among them are:
 * Boundary perturbation method
 * Domain decomposition method and parallel computing
 * Helmholtz equation and Maxwell equation in exterior domains
 * Splitting methods for incompressible flows
 * Phase–field model for complex fluids

Some typed lecture notes will be distributed. No textbook is needed.

MA 693C: Complex Analysis in Banach Spaces
Instructor: Prof. Lempert, office: Math 728, phone: 49–41952, e-mail: `lempert@math.purdue.edu`
Time: MWF 10:30
Prerequisite: Some knowledge of Several Complex Variables (MA 631 is more than enough) and of basic sheaf theory.
Description: The course will start with basics of the subject (holomorphic and plurisubharmonic functions, pseudoconvexity), then turn toward more modern developments: sheaf theory and analytic cohomology in Banach spaces.
References: 1.) Mujica, *Complex Analysis in Banach Spaces*, North Holland
2.) Original articles.

MA 694G: Elliptic and Parabolic PDEs II
Instructor: Prof. N. Garofalo, office: Math 616, phone: 49–41971, e-mail: `garofalo@math.purdue.edu`
Time: TTh 12:00-1:15
Description: This course is intended as a continuation of MA 694 taught in the Fall semester, Since the course will assume no special prerequisites it can be profitably taken also by students who have not taken MA 694 in the Fall. We will continue developing some recent, and less recent, trends in elliptic and parabolic PDE's related to variational inequalities and free boundary problems. Special emphasis will be given to parabolic equations and free boundary problems involving them. We will begin with a detailed discussion of those results on the boundary behavior of nonnegative solutions of parabolic PDE's in non-smooth domains whch constitute the backbone of the theory. We will then move on to discuss various free boundary problems and singular perturbation problems. We will discuss the Stefan problem and those more recent developments concerning two-phase free boundary problems, such as monotonicity formulas due to Alt-Caffarelli-Friedman and to Caffarelli, and their applications. The course will have an entirely self-contained character.
References: L. Caffarelli and S.Salsa, *A geometric approach to free boundary problems*

MA 694M: Levy Processes and Stochastic Analysis II
Instructor: Prof. Ma, office: Math 620, phone: 49–41973, e-mail: `majin@math.purdue.edu`
Time: TTh 1:30-2:45
Prerequisite: MA538, 539, or consent of instructor.
Description: This is a continuation of MA694F of Fall 2005. Upon finishing the text book materials, the main focus of the course will be the topic of stochastic differential equations driven by Lévy processes. In particular, some recent study of SDEs driven by symmetric stable processes will be studied in depth. Some applications of Lévy processes and stable processes in option pricing theory in finance will be presented as well.
Text: David Applebaum *Lévy Processes and Stochastic Calculus*, Cambridge Studies in advanced mathematics **93**, Cambridge University Press, 2004.
Suggest Reading: 1) J. Bertoin *Lévy Processes*, Cambridge University Press (1996)
2) K-I. Sato, *Lévy Processes and Infinitely Divisible Distributions*, Cambridge University Press (1999).

MA 694S: Stochastic Partial Differential Equations II

Instructor: Prof. Roeckner, office: Math 432, phone: 49–41963, e-mail: `roeckner@math.purdue.edu`

Time: TTh 10:30-11:45

Prerequisite: MA 694R, or consent of the instructor

Description: This will be the second part of MA 694R (though newcomers are welcome). The contents of the course will very much depend on how much material of the subject will be covered by the course in the fall semester 2005. Possible topics to be included are: mild solutions of SPDE (existence, uniqueness, special properties, their invariant measures), Kolmogorov equations in infinite dimensions, stochastic Navier-Stokes equations (in particular in 3 dimensions).

References: 1) Giuseppe DaPrato, Jerzy Zabczyk, *Stochastic Equations in Infinite Dimensions*, Cambridge University Press 1992.

2) Giuseppe DaPrato (editor), *Lecture Notes Math. 1715*, Springer 1999.

3) Franco Flandoli, *Stochastic Navier Stokes Equations in 3D*, Lectures given at CIME Summer School, Cetraro 2005, Lecture Notes Math., Springer 2005, to appear.

MA 696W: Resolution of Singularities in Characteristic Zero

Instructor: Prof. Wlodarczyk, office: Math 602, phone: 49–62835, e-mail: `wlodar@math.purdue.edu`

Time: TTh 10:30-11:45

Prerequisite: none

Description: We want to discuss the subject of singularities and their resolution from scratch. One of the goals of this course is to present a simplified Hironaka algorithm of resolution of singularities of algebraic varieties and analytic spaces.

Text: Wlodarczyk *Simple Hironaka Resolution*, JAMS

References: 1.) Kollar *Settle lecture*

2.) Cutkosky *Resolution of singularities*

3.) Villamayor (and simplification by Wlodarczyk and Matsuki), *Resolution of singularities in characteristic zero with focus on the inductive algorithm*

4.) Wisniewski *Notes on singularities*

Seminars

Algebraic Geometry Seminar, Prof. Abhyankar
Time: Thursday 4:30–6:00

Automorphic Forms and Representation Theory Seminar, Prof. Yu
Time: Thursdays, 1:30

Commutative Algebra Seminar, Prof. Heinzer
Time: Wednesdays 4:30-5:20

Computational and Applied Math Seminar, Prof. Shen
Time: Fridays 3:30

Computational Finance Seminar, Prof. Ma
Time: Fridays 2:30

Function Theory Seminar, Prof. Eremenko
Time: flexible.

Geometric Analysis Seminar, Prof. Lempert
Time: Monday 3:30

Foundations of Analysis Seminar, Prof. de Branges
Time: Thursday 9:30-10:20

Mathematical Biology, Prof. Feng
Time: Fridays, 2:30

Operator Algebras Seminar, Prof. Dadarlat
Time: Tuesdays, 2:30

PDE Seminar, Prof. Phillips
Time: Thursdays, 3:30

Probability Seminar, Prof. Viens
Time: Mondays 12:30

Spectral and Scattering Theory Seminar, Prof. Sá Barreto
Time: Thursdays 4:30

Topology Seminar, Prof. McClure
Time: Tuesday 1:30-2:20

Working Algebraic Geometry Seminar, Profs. Arapura and Matsuki
Time: Wednesday 3:30-5:00

Working Graduate Student Research Seminar - The FBI Transform, Profs. de Hoop and SaBarreto
Time: Tuesdays and Thursdays 10:30