Courses and Seminars of Interest to Graduate Students
offered by the
Mathematics Department
Spring, 2004

MA 490N: Introduction to Computational Neuroscience
Instructor: Prof. C. Cowen, office: Math 428, phone: 49–41943, e-mail: `cowen@math.purdue.edu`
Time: TTh 12:30 and T 1:30
Prerequisite: MA 366, The course is intended for advanced undergraduate students or graduate studnets in the mathematical or biological sciences.
Description: Leaders in the National Science Foundation and the National Institutes of Health believe that computational and mathematical methods increasingly will provide the foundation for advances in the biological sciences. This course is intended to provide an introduction to mathematical modeling of the biological processes involved in neuroscience. The course will begin with a brief introduction to differential equations and the basic biology underlying the electrical processes in neurons. Classsical systems of differential equations, such as those of Hodgkin–Huxley, FitzHugh–Nagumo, and Morris–Lecar, used to describe firing of action potentials in neurons and their propagation through networks will be developed and analyzed. These ideas and these models describe a diverse set of biological systems and organisms, from action potentials in the giant axon of the squid to control of insulin in pancreatic beta cells to understanding the effect of dopamine in the thalamus of Parkinson's patients. The course will introduce ideas from dynamical systems to understand the behavior of these models, especially the ways in which the behavior changes as the inputs and biological parameters change. Since systems of differential equations of biological importance do not (usually) have closed form solutions, software packages *Neuron* and *XPPAUT* will be used to do modeling and computations with the resulting modes. The course will emphasize setting up the models of neural systems and interpreting the computed solutions in the context in which the models arose and the dependence of the predicted behavior on the inputs. In particular, the course will include work on phase plane analysis and bifurcations and this work will be supported computationally by *XPPAUT*. An important goal of the course is to help prepare students to work in an interdisciplinary environment that includes both mathematical and biological scientists.
Grading: The course grade will be based on a midterm exam, a final exam, homework assignments that include computation with the packages *Neuron* and *XPPAUT*, and a group report on a published model (chosen by the group members) that was not covered in the lectures.
Comments: This course does not assume that students bring biological sophistication to the course. It is expected that students will gain an appreciation for the kinds of information that mathematical and computational approaches can add to understanding the functioning of a neural system as an example of how mathematics can help understand the world. The course should enable students to extend their understanding of systems of differential equations and the resulting dynamical systems. Students with questions about the course or how it might fit into their plans of study may contact Carl Cowen at 49–91943 or `cowen@math.purdue.edu`
Text: 1. C. P. Fall, E. S. Marland, J. M Wagner and J. J. Tyson, editors, *Computational Cell Biology*, Springer, 2002.
2. S. H. Strogatz, *Non–linear Dynamics and Chaos*, Westview Press, 1994.

MA 598B: Continuum Physics with Polar and Mixture Theories
Instructor: Prof. J. Cushman, office: Math 816, phone: 49–48040, e-mail: `jcushman@math.purdue.edu`
Time: TTh 12:00-1:15
Description: The course will present and overview of continuum field theories starting with the basics of particle mechanics and their generalization to continuum concepts. The basic field equations will be developed for Stoksian fluids, elastic solids and viscoelastic materials. Mixture theory and hybrid mixture theory will be introduced to develop constitutive theories for swelling porous media which contain viscous and viscoelastic fluids. Micro polar theories will be developed and employed to study fluids with micro-structure

MA 598C: Finite Element Methods for Partial Differential Equations
Instructor: Prof. Z. Cai, office: Math 810, phone: 49–41921, e-mail: `zcai@math.purdue.edu`
Time: TTh 10:30-11:45
Prerequisite: MA 362, 351 and 523 or equivalent or consent of the instructor
Description: Mathematical aspects of the finite element method applied to elliptic, parabolic and hyperbolic partial differential equations. Topics in approximation theory in two dimensions and the numerical solution of sparse linear systems. Other topics at the discretion of the instructor.
Text: C. Johnson *Numerical Solutions of Partial Differential Equations by the Finite Element Method*, Cambridge Press.

MA 598D: Designing your own Course
Instructor: Dr. R. Saerens, office: Math 826, phone: 49–41906, e-mail: `saerens@math.purdue.edu`
Time: Th 1:30 - 3:10 every other week, 1 credit – pass/fail
Target audience: mathematics graduate students who plan an academic career
Maximum Enrollment: 12 students
Prerequisite: having taught a course in which you were responsible for writing midterm exams or permission from the instructor
Description: The main objective of the course is to have the students (as a group) develop an Introduction to Real Analysis course for sophomores and juniors. The class will meet every other week for (at most) 100 minutes. Though various topics are scheduled for the different meetings, the content, etc. of the course will mostly be determined by the students. Homework will be assigned each class meeting and will be due the next week. Copies of the homework will be distributed and students are expected to have read and be ready to discuss the homeworks at the next class meeting.

Since this is a highly participatory course, grades will be based on attendance, preparation for and participation in the discussions, and the homework. Homework will not be graded for correctness but a certain amount of effort and thoughtfulness is expected.

MA 598E: Local Cohomology, an Introduction
Instructor: Prof. H. Walther, office: Math 746, phone: 49–62690, e-mail: `walther@math.purdue.edu`
Time: MWF 10:30
Description: Target Population: graduate students with interest in algebra and algebraic geometry.
Requirements: Interest in commutative algebra. Knowledge of the material of the algebra core course. Having taken Commutative algebra and/or Homological Algebra a plus but not necessarily required. Some ideas of Algebraic Topology are helpful. What one should know is the meaning of

* category, functor, complex
* short/long exact sequence
* Spec of a ring, variety, sheaf

But no working experience with these concepts will be required.
Book: We will use lecture notes by Mel Hochster (unpublished), and mix it with the book by Brodmann/Sharp (Cambridge press).

If you happen to know about "usual" cohomology, then local cohomology is the algebraic version of relative usual cohomology. I.e., it is designed to make a certain long sequence exact. As such, the study of local cohomology is related to algebraic topology, but also to the theory of Cohen-Macaulay rings, and algebraic geometry.

Otherwise, and in more concrete terms, it measures the difference between a ring R and it localization R_f at some f in R. (All rings with names like R or S are commutative and have a 1.) For a collection $f_1, \ldots, f_r$ in R one can form some sort of localization at all of the f at once, in terms of a complex, and local cohomology is the cohomology of this complex. One can also do local cohomology to a module, which sort of corresponds to comparing sections of a bundle on some space to the sections of the same bundle on an open subset.

(Non)Vanishing of these modules has to do with the number of generators for an ideal (= number of equations needed to define a variety), with depth, with dimension (of the module), connectedness of varieties and other such things.

There are several equivalent ways of defining local cohomology and we will discuss them to some detail. In order to do this we will discuss injective modules and their properties, flat modules, direct limits, a bit of spectral sequences, Cohen-Macaulay property, Matlis duality, Ext, Koszul complex, derived functors.
Content (somewhat sketchy):

* review of basic material from commutative algebra: dimension theory, regular sequence, complete intersection ring, Cohen-Macaulay ring, free resolution, injective resolution, Ext, Matlis duality,
* the functor $\Gamma_I(-)$ for an ideal. The idea of derived functors. Local cohomology. Connection to Cech complex.
* Other ways of expressing local cohomology: intro to direct and inverse limits, LC via Ext and Koszul complexes, delta-functors, connections to schemes,
* Mayer-Vietoris, excision, flatness, Gorenstein rings, canonical modules, connectedness theorems,
* Vanishing results: ideal generation, Grothendieck, relation to depth, MacDonalds' examples on nonvanishing, Faltings-Huneke-Lyubeznik, dependence on characteristic, Peskine-Szpiro, Hartshorne-Lichtenbaum, local duality
* Computational Approach 1: intro to Macaulay2, limits of Koszul complexes, relation to toric varieties after Eisenbud-Mustata-Stillman, monomial case following Yanagawa
* Computational approach 2: intro to D-modules, Bernstein-Sato polynomials, algorithms by Oaku-Takayama-Walther,
* Finiteness results: Singh-Katzman counterexamples, Huneke-Sharp and Lyubeznik in char 0 and p,
* Examples: LC of Stanley-Reisner ideals, LC versus solutions of GKZ-systems, LC of semigroup rings.

It is possible that we will not have time to do all this.

MA 598G: An Introduction to Geometric Measure Theory
Instructor: Prof. D. Danielli, office: Math 802, phone: 49–41920, e-mail: `danielli@math.purdue.edu`
Time: TTh 1:30-2:45
Prerequisite: MA 544 and MA 545, or equivalent (with instructor's consent)
Description: The purpose of this course is to provide an overview of the measure theoretic structure of R^n, with particular emphasis on integration and differentiation. Topics presented in the class will include: Hausdorff measure; Lipschitz functions and Rademacher's Theorem; Area and Coarea Formulas; Traces, extensions, and pointwise properties of Sobolev and BV functions; Capacity; Isoperimetric inequalities; The reduced and the measure theoretic boundary; Alexandrov's Theorem (asserting the twice differentiability of convex functions a.e.).
Text: L.C. Evans and R.F. Gariepy, *Measure Theory and Fine Properties of Functions,* CRC Press.

MA 598K: Applied Functional Analysis
Instructor: Prof. B. Lucier, office: Math 634, phone: 49–41979, e-mail: `lucier@math.purdue.edu`
Time: MWF 11:30
Prerequisite: A knowledge of metric spaces (MA 504) and linear algebra (MA 511).
Description: The course will cover the following topics: (1) Quick review of metric spaces; contraction mapping theorem. (2) Banach spaces—linear spaces and norms; linear functionals and the dual space; weak convergence; Hahn-Banach Theorem, Open Mapping Theorem, Uniform Boundedness Theorem. (3) Hilbert spaces—inner products; Lax-Milgram Lemma. (4) Other topics—compact operators; the spectral theorem; nonlinear operators.
Note: This course will cover rigorously the major structures and theorems of basic functional analysis. Rigorous treatments will be included for simple example spaces, such as sequence spaces; L_p spaces, which require measure theory to cover properly, will be treated less rigorously. Ph.D. students in pure and applied mathematics should take MA 546 or MA 611, respectively, instead of this course to prepare for further study.
Proposed Text: Charles W. Groetsch, *Elements of Applicable Functional Analysis*, Dekker.

MA 598S: Introduction to Semiclassical Microlocal Analysis
Instructor: Prof. P. Stefanov, office: Math 742, phone: 49–67330, e-mail: `stefanov@math.purdue.edu`
Time: MWF 1:30
Prerequisite: MA 504 or similar, MA 523 or similar.
Description: In this course, we will develop the basic principles of the theory of h-pseudodifferential operators and the local theory of h-Fourier integral operators. This calculus is useful for studying spectral asymptotics, small (or large) parameter asymptotics, etc. The main motivation for Semiclassical Microlocal Analysis comes from Quantum Mechanics: it gives us a tool to study the properties of the solutions of the Schrödinger equation in the so-called semiclassical limit, i.e., as Plank's constant h tends to 0. In particular, those solutions are expected to behave like the ones of the corresponding classical mechanical system. This theory has many similarities with the classical Microlocal Analysis but can be developed independently of it. No apriori knowledge of Microlocal Analysis or Quantum Mechanics is needed and only general knowledge of Functional Analysis (Hilbert spaces and spectral theory), Fourier transform and theory of distributions is required.

The following topics will be covered: Definition and basic properties of h-pseudodifferential operators (h-ΨDOs); construction of parametrix of elliptic h-ΨDOs; local Fourier Integral Operators; wave front set and propagation of singularities; Egorov's theorem; sharp Garding inequality; spectral asymptotics of self-adjoint h-ΨDOs, applications to the semiclassical Schrödinger equation (potential well and tunnel effect), scattering by a convex obstacle (high frequency asymptotics of the scattering matrix), etc.

The main books related to this course are:
(1) M. Dimassi and J. Sjöstrand, *Spectral Asymptotics in the Semi-Classical Limit*, Cambridge Univ. Press, 1999.
(2) A. Martinez, *An Introduction to Semiclassical and Microlocal Analysis*, Springer, 2002.
A large part of the material however is based on publications within the past 10–15 years and is not contained in the books above.

MA 598Y: Algebraic Number Theory
Instructor: Prof. J-K Yu, office: Math 738, phone: 49–41946, e-mail: `jyu@math.purdue.edu`
Time: TTh 10:30-11:45
Prerequisite: MA 553 and 554
Description: This course is of broad interest to graduate students and advanced undergraduate students interested in number theory, (arithmetic) algebraic geometry, automorphic forms, or representation theory. It has a sequel on class field theory, and should be offered in Fall 2004 by Prof. Shahidi.

Topics: Dedekind domains, norm, discriminant and different, finiteness of class number, Dirichilet unit theorem, quadratic and cyclotomic extensions, quadratic reciprocity, decomposition and inertia groups, completions and local fields.
Text: Serge Lang, *Algebraic Number Theory*, 2nd Ed., Springer–Verlag, 1994.

MA 611: Methods of Applied Mathematics I
Instructor: Prof. P. Bauman, office: Math 718, phone: 49–41945, e-mail: `bauman@math.purdue.edu`
Time: MWF 10:30
Prerequisite: Math 511 and Math 544 (or equivalent).
Description: Banach & Hilbert spaces; theory of linear operators; spectral theory; applications to linear integral equations and Sturm-Liouville problems for differential equations.

CS 614: Numerical Solutions of Ordinary Differential Equations (with applications to partial differential equations)
Instructor: Prof. J. Shen, office: Math 806, phone: 49–41923, e-mail: `shen@math.purdue.edu`
Time: TTh 9:00-10:15
Prerequisite: CS 514
Description: Numerical solutions of initial–value problems by Runge—Kutta methods, general one–step methods, and multistep methods; analysis of truncation error, discretization error, and rounding error; stability of multistep methods; applications of these time stepping schemes for solving partial differential equations.

MA 631: Several Complex Variables
Instructor: Prof. D. Catlin, office: Math 744, phone: 49–41958, e-mail: `catlin@math.purdue.edu`
Time: MWF 2:30
Prerequisite: MA 530
Description: Power series, holomorphic functions, representation by integrals, extension of functions, holomorphically convex domains. Local theory of analytic sets (Weierstrass preparation theorem and consequences). Functions and sets in the projective space P^n (theorems of Weierstrass and Chow and their extensions).

MA 643: Methods of Linear and Nonlinear Partial Differential Equations II
Instructor: Prof. N. Garofalo, office: Math 616, phone: 49–41971, e-mail: `garofalo@math.purdue.edu`
Time: TTh 10:30-11:45
Description: This course will be a continuation of MA 642, only in the sense that the material covered in the Fall semester constitutes a useful exposure to some of the tools and ideas used in pde's. In reality, the course will have a self-contained character, and can be profitably attended also by students who have not taken MA 642 in the Fall, provided that they are willing to make a serious effort. We will continue the study of some of the main trends in pde's of the second order, with special emphasis on topics which lie at the interface of classical analysis and geometry. Topics to be covered are L^p theory for solutions of elliptic equations, including Moser's estimates, Alexandrov maximum principle, and the Calderon-Zygmund theory. We will discuss the Yamabe problem, its solution, and its ramifications. We will also give an introduction to the theory of minimal surfaces and generalized perimeters, and present some of the basic results in this subject.

MA 646: Banach Algebras and C^*-algebras
Instructor: Prof. L. Brown, office: Math 704, phone: 49–41938, e-mail: `lgb@math.purdue.edu`
Time: MWF 12:30
Prerequisite: MA 546 or equivalent
Description: C^*-algebras originally arose for use in quantum mechanics and also have important relationships with geometry, topology, and probability. Although the course will not cover these advanced applications, it will provide the background needed for them. The course will begin with Banach algebras and the Gelfand theory theory for commutative Banach algebras. Then comes the basic theory of $^C*$-algebras and representations, including the non-commutative Gelfand-Naimark theorem. The course will also include some of the basic theory of von Neumann algebras.
No text will be formally used, but here are some good references:

1. J. Conway, *A Course in Functional Analysis, Chapters VII,VIII*
2. J. Dixmier, *C^*-algebras and Their Representations*
3. John von Neumann, *Collected Works, Vol. 3*
4. G. Pedersen, *C^*-algebras and Their Automorphisms*
5. S. Sakai, *C^*-algebras and W^*-algebras*
6. P. Fillmore, *A User's Guide to Operator Algebras*
7. K. Davidson, *C^*-algebras by Example*

MA 661: Modern Differential Geometry
Instructor: Prof. H. Donnelly, office: Math 716, phone: 49–41944, e-mail: `hgd@math.purdue.edu`
Time: MWF 11:30
Prerequisite: MA 562
Description: Riemannian geometry, model spaces, connections, geodesics, curvature, second fundamental form, Jacobi fields, curvature and toplogy.

Laplace operator, spectrum of model spaces, upper and lower bounds for the first eigenvalue, heat equation asymptotics, concentration of eigenfunctions, quantum unique ergodicity, spectral stability.
Text: Lee, J. *Riemannian manifolds*, Springer graduate texts, 1997.
Reference: Berger, M. *Le Spectre d'une Varieté Riemannienne*, Springer Lecture Notes 194, 1971.

MA 664: Algebraic Curves and Functions II
Instructor: Prof. S. Abhyankar, office: Math 600, phone: 49–41933, e-mail: `ram@math.purdue.edu`
Time: TTh 1:30-2:45
Description: Algebraic geometry, concerned with solutions of systems of polynomial equations, and their graphical representations, has for long been regarded as a very abstract area of mathematics. However, recently, with the advent of high-speed computers, applications have come about in such diverse areas of science and engineering such as theoretical physics, chemical, electrical, industrial and mechanical engineering, computer aided design (CAD), computer aided manufacturing (CAM), optimization, and robotics. These application areas are also increasingly posing fundamental open mathematical questions. This course is intended as an introduction to various relevant topics in algebraic geometry such as:
- Analysis and resolution of singularities
- Rational and polynomial parametrization
- Intersections of curves and surfaces
- Polynomial maps
- Fundamental Groups and Galois groups

The lectures will be expository in nature and so will be accessible to everyone. Thus there are no formal prerequisites and all interested students are welcome. Although this will be a continuation of Part I (MA 663) which I am teaching this Fall, new interested students can follow it with a little extra work.
Texts:
1. *Algebraic Geometry for Scientists and Engineers* by Shreeram S. Abhyankar, Published by Amer Math Soc
2. *Resolution of Singularities of Embedded Algebraic Surfaces* by Shreeram S. Abhyankar, Published by Springer Verlag

MA 665: Toric Varieties, an Introduction to Algebraic Geometry
Instructor: Prof. J. Wisniewski, office: Math 626, phone: 49–41969, e-mail: `wisniew@math.purdue.edu`
Time: TTh 12:00-1:15
Webpage: MA 665 for Spring 2004 has a webpage: `http://www.mimuw.edu.pl/~jarekw/toric`
Summary: The course is aimed at graduate students but with low prerequisites, the task is to make an easy introduction of basic concepts of Algebraic Geometry, to varieties over complex numbers, from the standpoint of toric varieties.
Main text: notes to 1 week intensive course in Grenoble course by Cox, Brion, Barthel and Bonavero, available at Bonavero's web page (`http://www-fourier.ujf-grenoble.fr/~bonavero/articles/ecoledete/ecoledete.html`)

Out of 20 lectures I expect to cover lectures 1 - 12 (notes to some lectures are very sketchy though). Additional books: Harsthorne, *Algebraic Geometry*; Harris: *Algebraic Geometry: a first course*; Eisenbud, Harris: *The geometry of schemes*; Mumford: *Projective algebraic geometry*; Szafarewicz: *Osnowy algebraiczeskoj geometrii*; Fulton: *Introduction to toric varieties*;

Prerequisites: basic knowledge of algebra (linear algebra, rings and fields), basics of topology and analysis (including generalities on complex functions).
Tentative contents of the course:

1. Complex affine varieties: Nullstellensatz, Zariski topology, regular functions. Relation: affine varieties $\Longleftrightarrow$ finitely generated C-algebras without nilpotents. Irreducible varieties, field of rational functions. Maps of affine varieties. Products of affine varieties.
2. Affine toric varieties. Lattices and cones. Faces of cones and related open affine subsets. Maps of affine toric varieties. Big torus and its action on affine toric varieties, one parameter subgroups, fixed points.
3. Zariski tangent space, smoothness and Jacobian criterion for affine varieties. Regular cones and smooth toric varieties.
4. Sheaves. Abstract varieties sheaf of regular functions. Gluing varieties. Separability. Projective varieties. Fans and construction of toric varieties. Separability for toric varieties.
5. Morphisms of varieties. Veronese and Segre maps. Birational morphisms. Dividing fans and birational morphisms of toric varieties. Blowups. Sub-latices and finite morphisms. Singularities of toric surfaces, quotients via abelian groups. Weighted projective space and fake weighted projective space.
6. Torus action on a toric variety. Orbit decomposition and relation to cones in the fan. Action of 1-parameter group, sources and sinks, Bialynicki-Birula decomposition for smooth toric varieties.
7. Vector bundles on varieties: transition functions, Čech cocycles and sections of vector bundles. Line bundles, Cartier divisors, principal divisors, linear equivalence, Picard group. Sections of line bundles, linear systems and maps into projective space. Picard group of toric varieties, sections of line bundles on toric varieties

Additional information: students are expected to solve problems, homework will be assigned regularly. Apart of regular lectures we expect to have problem solving sessions and quizzes. Similar course was done in Fall 2002 at Warsaw University, at it's website. (`http://www.mimuw.edu.pl/~jarekw/SZKOLA/oldstuff/toric/toricga.html`)

MA 690B: Topics in Commutative Algebra
Instructor: Prof. W. Heinzer, office: Math 636, phone: 49–41980, e-mail: `heinzer@math.purdue.edu`
Time: MWF 3:30
Description: The course is planned as a continuation of MA 690B of this semester. I intend to cover topics from the book *Cohen-Macaulay Rings* by W. Bruns and J. Herzog. Among topics I hope to cover are the canonical module, Gorenstein rings, Hilbert functions and multiplicities.

MA 690S: Classification of Semisimple Algebraic Groups
Instructor: Prof. F. Shahidi, office: Math 650, phone: 49–41917, e-mail: `shahidi@math.purdue.edu`
Time: MWF 9:30
Prerequisite: MA 553 and 554
Description: The purpose of this course is to study the structure and give a classification of semisimple algbraic groups over perfect fields. We will start with reviewing some basic algebraic geometry background and go through the definitions and proofs of the main results about algebraic groups (nilpotent, solvable, semisimple, reductive). We then concentrate on semisimple and reductive groups and study their basic structures: Tori and Cartan subgroups, root systems, Weyl groups, parabolic subgroups and flags, Chevalley and Steinberg groups; inner forms and finally classification. The cases of real and complex linear Lie groups will be included as their fields are automatically perfect.
References:

1. I. Satake, *Classification of Semisimple Algebraic Groups*, Marcel–Decker, 1971.
2. T. A. Springer, *Linear Algebraic Groups*, Second Edition, Birkhauser.
3. A. Borel *Linear Algebraic Groups*, Second Edition, GTM 126.

MA 693A: Mapping Problems in Complex Analysis
Instructor: Prof. S. Bell, office: Math 740, phone: 49–41956, e-mail: `bell@math.purdue.edu`
Time: MWF 1:30
Description: I will show how the Bergman kernel function can be used to attack many problems on conformal mapping in the plane and problems on boundary behavior of holomorphic mappings in several complex variables. I will also cover developments in complex analysis arising from the remarkable discovery made in 1978 by N. Kerzman and E. M. Stein that the centuries old Cauchy Transform is nearly a self adjoint operator when viewed as an operator on L^2 of the boundary. This new, but fundamental, result represented a shift in the bedrock of complex analysis. It has allowed the classical objects of potential theory and conformal mapping in the plane to be constructed and analyzed in new and very concrete terms. In particular, I shall show how quadrature domains in the plane can be used to simplify the objects of potential theory.

Among the topics that I shall cover will be

- Boundary behavior of the Cauchy transform and applications.
- The Szegő kernel function as the first building block of potential theory.
- The Bergman kernel and projection in $\mathbb{C}$ and $\mathbb{C}^n$
- The Ahlfors mapping and its importance in complex analysis and potential theory in the plane.
- A constructive approach to the classical objects of conformal mapping and potential theory.
- Quadrature domains and complexity in complex analysis.

Prerequisite: The only prerequisite for the course is MA 530. There will be some overlap with the material of MA 531, but not much.

I hope that at the end of this course a student will be ready to start work on a thesis problem in either pure complex analysis or numerical conformal mapping and potential theory.

MA 693B: Foundations of Analysis
Instructor: Prof. L. de Branges de Bourcia, office: Math 800, phone: 49–46057, e-mail: `branges@math.purdue.edu`
Time: MWF 10:30
Description: Theses preparations for a doctoral thesis in analysis supplement required courses. A formulation of set theory is first made. A proof of the Zorn lemma is given from the axiom of choice. The Cantor construction of sets of arbitrary cardinalities is made. A proof is given of compactness of Cartesian products of compact Hausdorff spaces. The course is otherwise concerned with a hyperconvex generalization of the Hahn–Banach theorem. Weierstrass algebras of continuous functions on a Hausdorff space are introduced. A generalization of the Stone–Weierstrass theorem is obtained for functions on noncompact Hausdorff spaces. A construction of invariant subspaces is made for dual algebras of continuous linear transformations on a primitive locally convex space. The course is intended for students who have passed qualifying examinations in analysis, but can also be usefully taken by students who are preparing for these examinations.

MA 697W: Intermediate Homological Algebra
Instructor: Prof. C. Wilkerson, office: Math 450, phone: 49–41955, e-mail: `wilker@math.purdue.edu`
Time: MWF 1:30
Prerequisite: Ext and Tor for modules over a ring.
Description: The course will consider Hochshild and Andre-Quillen cohomology theories. In the process, it will introduce simplicial non-abelian methods. These theories have become important in modern algebraic topology and extend to structured ring spectra. It should be of interest to students in topology and algebra.
Text: Weibel, *Introduction to Homological Algebra*

Seminars

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

Automorphic Forms and Representation Theory Seminar, Prof. Yu
Time: Thursdays, 1:30-2:30

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

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

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

Linear and Complex Analysis Seminar, Prof. de Branges
Time: Thursday 10:30-11:20

Mathematical Biology, Prof. Feng
Time: Friday, 11:30-12:20

Operator Algebras Seminar, Prof. Dadarlat
Time: Tuesdays, 2:30-3:20

PDE Seminar, Prof. Phillips
Time: Tuesdays, 9:30-10:20

Student PDE Seminar, Prof. Garofalo
Time: Wednesday 10:30-11:20

Topolgy Seminar, Prof. Mauer–Oates
Time: Thursdays 1:30-2:20

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