Second International Workshop on Differential Algebra and Related Topics

April 12–13, 2007

Bove Auditorium, Engelhard Hall
190 University Avenue
Rutgers, The State University of New Jersey
Newark, New Jersey, USA

Program

with information on
AMS Special Session on Differential Algebra
April 13–14, 2007
Stevens Institute of Technology

The organizers of the Workshop gratefully acknowledge funding from the National Security Agency, The National Science Foundation and the Office of the Provost, the Office of the Dean of the Faculty of Arts and Sciences-Newark and the Department of Mathematics and Computer Science of the Newark campus of Rutgers, The State University of New Jersey.

Contents

1 Workshop Schedule

All talks will take place in the Bove Auditorium, located on the first floor of Engelhard Hall, 190 University Ave. When you walk from the Robert Treat Hotel along New Street, Engelhard Hall is on your left at the intersection with University Avenue. See Figure 2 *on page* 13.

Thursday, April 12

8:00–8:45	Registration and Refreshments	
8:45–9:00	Welcoming remarks	
9:00–10:00	Michael Singer	Differential Dependence and Differential Groups
10:15–11:15	Russell Miller	Computable Model Theory and Differential Algebra
11:30–12:30	Peter Clarkson	The Painlevé Equations—Nonlinear Special Functions
12:30–2:00	Lunch Break	
2:00–3:00	Greg Reid	Introduction to Symbolic-Numeric Completion Methods for PDE
3:15–4:15	Marcelo Aguiar	Overview of Baxter Algebras
4:15–4:45	Refreshments (Esterly Lounge, second floor)	
4:45–5:45	B. Heinrich Matzat	Differential Galois Theory in Positive Characteristic: An Introduction
6:30	Banquet Dinner University Club, second floor of Robeson Campus Center	

Friday, April 13

8:30–9:00	Registration and Refreshments	
9:00–10:00	Mark van Hoeij	Solving Second and Third Order Linear ODE's in Terms of Special Functions
10:15–11:15	Andy Magid	The Complete Picard-Vessiot Closure of the Constants
11:30–12:30	David Marker	Model Theory and Differential Algebra
12:30–2:00	Lunch Break	
2:00–3:00	Robert Grossman	Hopf Algebras of Labeled Trees and Some Associated Differential Algebra Structures
3:15–4:15	Marius van der Put	Solving Linear Differential Equations
4:15–5:30	Refreshments and Poster Session (Room 301 Engelhard Hall)	

2 Workshop Talk Abstracts

Differential Dependence and Differential Groups

Michael F. Singer

Dept. of Math., North Carolina State University, Box 8205, Raleigh, NC 27695-8205 (singer@math.ncsu.edu)

I will develop a Galois theory of linear difference equations where the Galois groups are linear differential groups. These groups measure the differential dependence among solutions of linear difference equations. We will show how this theory can be used to prove anew Hölder's Theorem that the Gamma function satisfies no differential polynomial equation, Hardouin's recent results concerning differential dependence of solutions of first order difference equations and new results concerning differential dependence of solutions of higher order difference equations.

Computable Model Theory and Differential Algebra

Russell G. Miller

Dept. of Math., Queens College of CUNY, 65–30 Kissena Blvd., Flushing, New York 11367 (Russell.Miller@qc.cuny.edu)

Model theory is the study of mathematical structures and the extent to which they can be described by statements and formulas. Computable model theory considers the effectiveness of results in model theory: whether they can actually be given or realized by algorithms. For example, a computable field is a field F in which the basic operations of addition and multiplication can be computed algorithmically, and one can then ask whether there exists a *splitting algorithm* for deciding whether a given polynomial in $F[X_1, \ldots, X_n]$ is reducible there.

We will give a tutorial in computable model theory, oriented towards results on fields and towards an audience with no serious background in either computability or model theory. Differential algebra is a natural subject for study by computable model theorists, yet there are precious few results for computable differential fields. (It should be understood that this is not the same thing as *computational* differential algebra, although there certainly should be some relation between the two.) As an example, we will describe Rabin's well-known result that every computable field F has a computable algebraic closure, but that F itself can be a computable subfield of the algebraic closure if and only if there is a splitting algorithm for $F[X]$. One would expect some sort of analogous result for computable differential fields and their differential closures, yet to the speaker's knowledge, no such work has been done.

Computable model theory has always restricted itself to countable structures, since the natural domain for computability is the natural numbers. However, we will present work by the speaker which also considers certain uncountable structures $\mathcal{S}$, called *locally computable*

structures, by effectively describing the finitely generated substructures of $\mathcal{S}$, rather than giving a global description of $\mathcal{S}$. This concept was only recently developed and has not as yet been widely applied, but fields and differential fields are natural choices for its use.

The Painlevé Equations—Nonlinear Special Functions

Peter A. Clarkson

Institute of Mathematics, Statistics and Actuarial Science, University of Kent, Canterbury, Kent, CT2 7NF, United Kingdom

(P.A.Clarkson@kent.ac.uk)

The six Painlevé equations ($\mathrm{P_I}$–$\mathrm{P_{VI}}$) were first discovered around the beginning of the twentieth century by Painlevé, Gambier and their colleagues in an investigation of nonlinear second-order ordinary differential equations. Recently there has been considerable interest in the Painlevé equations primarily due to the fact that they arise as reductions of the soliton equations which are solvable by inverse scattering. Although first discovered from strictly mathematical considerations, the Painlevé equations have arisen in a variety of important physical applications including statistical mechanics, random matrices, plasma physics, nonlinear waves, quantum gravity, quantum field theory, general relativity, nonlinear optics and fibre optics. Further the Painlevé equations may be thought of a nonlinear analogues of the classical special functions.

In this lecture I will give an introduction to the Painlevé equations. In particular I shall discuss many of the remarkable properties which the Painlevé equations possess including connection formulae, Bäcklund transformations associated discrete equations, and hierarchies of exact solutions.

Introduction to Symbolic-Numeric Completion Methods for PDE

Greg Reid

Dept. of Appl. Math., University of Western Ontario, London, Ontario N6A5B7, Canada (reid@uwo.ca)

Differential elimination methods apply a finite sequence of differentiations and eliminations to general systems of PDE to extract potent information about their solutions. Much recent progress has been made in the design and implementation of exact algorithms, applying to exact input systems, by researchers such as Boulier, Hubert, Mansfied, Seiler, Wittkopf and others. Though powerful, such methods cannot be applied to approximate systems, since the strong underlying use of rankings of partial derivatives, often induces instability, by forcing such methods to pivot on small quantities.

The talk will be an introduction to the new area of symbolic-numeric methods for completion of PDE. Main features include the focus on geometric methods and the use of Homotopy

continuation methods for the detection of new constraints by slicing varieties in jet space with random hyperplanes. Our most recent work on this topic will be presented by Wenyuan Wu at the related AMS Special Session on Differential Algebra.

Overview of Baxter Algebras

Marcelo Aguiar

Dept. of Math., Texas A & M University, College Station, Texas 77843 (maguiar@math.tamu.edu)

We discuss old and recent results on Baxter algebras, from work of Cartier and Rota in the 60's to current work of Guo and others. We will touch on topics such as Spitzer's identity, Loday's dendriform algebras, and the Yang-Baxter equation, among others.

Differential Galois Theory in Positive Characteristic

An Introduction

B. Heinrich Matzat

IWR, University of Heidelberg, Im Neuenheimer Feld 368, D-69120 Heidelberg, Germany (matzat@iwr.uni-heidelberg.de)

We will give an introduction to differential Galois theory in positive characteristic and explain interrelations between Picard-Vessiot extensions in positive characteristic and in characteristic zero. The lecture summarizes work of M. van der Put and the speaker.

Solving Second and Third Order Linear ODE's in Terms of Special Functions

Mark van Hoeij

Dept. of Math., Florida State University, Tallahassee, FL 32306 (hoeij@math.fsu.edu)

In this talk an algorithm will be presented for solving any second or third order linear ordinary differential equation with rational function coefficients that is solvable in terms of Bessel, Kummer, or Whittaker functions.

The Complete Picard-Vessiot Closure of the Constants

Andy R. Magid

Dept. of Math., University of Oklahoma, 601 Elm Room 423, Norman, OK 73019 (amagid@ou.edu)

The compositum of all the Picard-Vessiot extensions of a given base differential field, unlike the algebraic closure of the field, may itself have proper Picard-Vessiot extensions. Iterating this, in general countably many times, produces a differential field that has no proper Picard-Vessiot extensions, and is minimal over the base with this property. This field is called the complete Picard-Vessiot closure. Its group of differential automorphisms over the base controls the differential subfield structure, even though the group is not (pro)algebraic and the correspondence is not a full Galois connection. We will focus on the natural special case when the base field is the (algebraically closed, characteristic zero) field of constants.

Model Theory and Differential Algebra

David Marker

Dept. of Math., Stat., and C. Sc., University of Illinois at Chicago, 851 S. Morgan St. (M/C 249) Chicago, IL 60607-7045

(marker@math.uic.edu)

Many model theoretic phenomena arise naturally in differential fields. We will describe some model theoretic questions that lead to interesting questions in differential algebraic geometry.

Hopf Algebras of Labeled Trees and Some Associated Differential Algebra Structures

Robert Grossman

Dept. of Math., Stat., and C. Sc., University of Illinois at Chicago, 851 S. Morgan St. (M/C 249) Chicago, IL 60607-7045

(grossman@uic.edu)

It is well known that the vector space spanned by rooted trees forms a Hopf algebra. We survey several such Hopf algebras and describe some of the their duals. In particular, we consider Hopf algebras H of trees that are labeled by derivations in $\mathrm{Der}(R)$. Here k is a field, R is a commutative k-algebra, and $\mathrm{Der}(R)$ is the Lie algebra of derivations of R.

We describe a construction that gives R an H-module algebra structure and show this induces a differential algebra structure of H acting on R. The construction extends the notion of a R/k-bialgebra introduced by Nichols and Weisfeiler.

This is joint work with Richard Larson.

Solving Linear Differential Equations

Marius van der Put

Dept. of Math., University of Groningen, P.O.Box 800, 9700 AV Groningen, Netherlands (mvdput@math.rug.nl)

We concentrate on linear differential equations (or differential modules) over the differential field $\mathbb{C}(z)$. The theme, probably introduced by L. Fuchs, is to solve a differential equation in terms of equations of lower order. This problem has led to the highly interesting paper of G. Fano (1900). The work of M. F. Singer opened a new perspective on this theme. We continue this direction and apply the powerful theory of representations of semi-simple Lie algebras in order to obtain a systematic way for solving the problem. This involves differential Galois theory, Tannaka theory, simple algebraic groups and it leads to algorithms.

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3 Workshop Poster Session Abstracts

Non integrability of some Hamiltonians with rational potential[1]

Primitivo Belén Acosta-Humánez

Dept. App. Math. II, Technical University of Catalonia, Jordi Girona 1–3, 08034 Barcelonia, Spain (primitivo.acosta@upc.edu)

In this work we compute the families of classical Hamiltonians with two degrees of freedom in which the Normal Variational Equation around an invariant plane falls in the Shrödinger type with polynomial or trigonometrical potential. In the first case we analyze the integrability of the Normal Variational Equation in the Liouvillian sense using the Kovacic's algorithm. We also introduce a method of algebraization that transforms equations with transcendental coefficients into equations with rational coefficients without changing the Galoisian structure of the equations. It allows us to deal with the second case via the universal covering of the cylinder. In both cases we obtain Galoisian obstructions to existence of a rational first integral of the original Hamiltonian via the Morales-Ramis theory.

[1] Joint work with David Blazquez-Sanz

An Introductory Differential Algebra Text

Brent Baccala

Freesoft.org,618 Laurel Dr, Pasadena, MD 21122 (cosine@freesoft.org)

Discussion of a proposed undergraduate-level introductory differential algebra text, including content and motivation. Sample pages will be provided. Feedback will be solicited.

Differentiation Index of Generic DAE Systems

Gabriela Jerónimo

Dept. of Math. (FCEyN), University of Buenos Aires, Argentina (jeronimo@dm.uba.ar)

The notion of the differentiation index for DAE systems of arbitrary order with generic second members is discussed. We prove an upper bound for the differentiation index in terms of the order of the input equations and we exhibit a probabilistic polynomial-time algorithm for the computation of this index. In addition, we obtain upper bounds for the regularity of the Hilbert-Kolchin function and the order of the ideal associated to the systems under consideration and we show how to compute an equivalent implicit ODE system.

Jacobi's Bound. Transmission and Oblivion of a Mathematical Notion

François Ollivier

ALIEN, INRIA–Futurs & LIX, l'École Polytechnique, F–91128 Palaiseau CEDEX, France (francois.ollivier@lix.polytechnique.fr)

Jacobi is one of the most famous mathematicians of his century. His name is attached to many results in various fields of mathematics and his complete works in seven volumes have been available since the end of the XIX$^{\text{th}}$ century and very often are quoted in many papers.

It is then surprising that some of his results may have fallen into oblivion, at least in part. We will try to understand this selective process and to describe it as a "family-tree," from the writing of Jacobi's manuscripts, around 1836 until today.

There are in fact many interrelated results: the bound itself, a necessary and sufficient condition for the bound to be reached that is given by a determinant, an algorithm to compute the bound in polynomial time, and processes for computing normal forms using as few derivatives as possible. The framework used by Jacobi is rather informal and his results can be made precise using various modern theories such as differential algebra, diffiety theory, etc. The conclusions and hypotheses could vary according to the authors.

We give for all of them the form under which they could have been proved or rediscovered, some independently of Jacobi's results.

Proof of $\zeta(3,3)=\zeta(\bar{2},1,\bar{2},1)$

Jianqiang Zhao

Dept. of Math., Eckerd College, 4200 54th Avenue South, St. Petersburg, Florida 33711 (zhaoj@eckerd.edu)

We'll show the identity in the title by using double shuffle relations and some identities among Euler sums up to weight 6. It is known to the experts that this identity follows from the double shuffle relations among Euler sums of weight 6. So the novelty of our result is that we can determine exactly which relations are needed. This might help us understand the general conjecture that $\zeta(\{3\}^n)=\zeta(\{\bar{2},1\}^n)$ for all positive integer n.

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4 Organizing Committee

- Phyllis Joan Cassidy, Smith College and City College of CUNY (pcassidy1@nyc.rr.com)
  Phone: (H) 1-212-222-1641, (C) 1-917-821-3734, (RTH) 1-973-622-1000
- Richard Churchill, Hunter College and Graduate Center of CUNY (rchurch@hunter.cuny.edu)
  Phone: (HC) 1-212-772-5304, (GC) 1-212-817-8561, (RTH) 1-973-622-1000
- Li Guo, Rutgers University at Newark (liguo@newark.rutgers.edu)
  Phone: (O) 1-973-353-5156 ext. 30, (H) 1-609-275-5191
- William Keigher, Rutgers University at Newark (keigher@andromeda.rutgers.edu)
  Phone: (O) 1-973-353-5156 ext. 29, (H) 1-732-574-1835
- Jerald Kovacic, City College of CUNY (jkovacic@verizon.net)
  Phone: (H) 1-212-505-0270 (C) 1-917-921-2998
- William Sit, City College of CUNY (wyscc@sci.ccny.cuny.edu)
  Phone: (O) 1-212-650-5179, (H) 1-718-549-2765, (C) 1-347-251-2390
- Yvette Ortiz-Beaumont (Administrative assistant) (yortiz@newark.rutgers.edu)
  Phone: (O) 1-973-353-1630, Fax: 1-973-353-1631

(H)=Home, (O)=Office, (C)=Cell, (HC)=Hunter College, (GC)=Graduate Center, (RTH)=Robert Treat Hotel *Feel free to contact any of the organizers if you need help.* Please note that 1 and the area codes have to be dialed even for local calls.

5 Workshop Participants

Primitivo Belén Acosta-Humánez, Technical University of Catalonia (Spain)
Marcelo Aguiar, Texas A&M University (U.S.A.)
Jonathan Aïdan, Institut de Mathématiques de Jussieu/Chevaleret (France)
Brent Baccala, freesoft.org (U.S.A.)
Phyllis J. Cassidy, Smith College and City College of CUNY (U.S.A.)
Richard Churchill, Hunter College and Graduate Center of CUNY (U.S.A.)
Peter Clarkson, Kent University (United Kingdom)
Richard M. Cohn, Rutgers University, New Brunswick (U.S.A.)
Adam Crock, Graduate Center of CUNY (U.S.A.)
Lucia Di Vizio, Institut de Mathématiques de Jussieu (France)
Scott Forrest, Oakland University (U.S.A.)
Oleg Golubitsky, Queen's University (Canada)
Robert Grossman, University of Illinois at Chicago (U.S.A.)
Li Guo, Rutgers University, Newark (U.S.A.)
Charlotte Hardouin, University of Heidelberg (Germany)
Gabriela Jerónimo, FCEyN, Universidad de Buenos Aires (Argentina)
Joseph L. Johnson, Rutgers University, New Brunswick (U.S.A.)
Lourdes Juan, Texas Tech University (U.S.A.)
William Keigher, Rutgers University, Newark (U.S.A.)
Jerald Kovacic, City College of CUNY (U.S.A.)
Andy Magid, University of Oklahoma (U.S.A.)
David Marker, University of Illinois at Chicago (U.S.A.)
B. Heinrich Matzat, University of Heidelberg (Germany)
Russell Miller, Queens College of CUNY (U.S.A.)
Claudine Mitschi, University of Strasburg (France)
John Michael Nahay, Burlington County College (U.S.A.)
François Ollivier, Laboratoire LIX, UMR CNRS-l'École Polytechnique (France)
Wei Yan Pong, California State University Dominguez-Hills (U.S.A.)
Gregory J. Reid, University of Western Ontario (Canada)
Camilo Sanabria, University of Leiden (Netherlands)
Michael Singer, North Carolina State University (U.S.A.)
Ravi Srinivasan, University of Oklahoma (U.S.A.)
Marius van der Put, University of Groningen (Netherlands)
Mark van Hoeij, Florida State University (U.S.A.)
William Sit, City College of CUNY (U.S.A.)
Franz Winkler, RISC, J. Kepler Universität (Austria)
Wenyuan Wu, University of Western Ontario (Canada)
Yanyan Yu, Nankai University (China)
Jianqiang Zhao, Eckerd College (U.S.A.)

6 Transportation and Parking in Newark

6.1 Between Newark and the Airports

There are three major airports in the NYC-Newark area: Newark International Airport, JFK Airport and LaGuardia Airport. The phone number of the Port Authority of New York and New Jersey is (212) 435-7000.

Newark Airport: Both Robert Treat Hotel and Hampton Inn provide free shuttle service to and from the airport. A taxi between the airport and the hotels costs about $11.00 one way. There are also bus services between the airport and Penn Station in Newark (note that there is also a Penn Station in New York City). Hampton Inn also has shuttles to Penn Station. To get from Robert Treat to Penn Station, you can take a cab or take the Newark Light Rail (see §.6.3) to Penn Station from the Military Park Station or from NJPAC/Center Street Station.

JFK Airport or LaGuardia Airport: You can take a cab or the City Subway to Newark Penn Station, as described in the last paragraph. From there you take one of the NJ Transit trains to Penn Station in New York which is the last stop. Then you can take the subway or shuttle to the airports.

6.2 Between Robert Treat Hotel and Newark Campus

Please refer to maps in Figure 1 on page 12 and Figure 2 on page 13.

To walk from Robert Treat Hotel to Engelhard Hall, start from the front exit of the hotel, cross Park Place, and go directly through Military Park. Cross Broad Street at the New Street traffic light. Walk on New Street for two blocks, cross Washington Street, and continue on the pedestrian path (formerly New Street) for one more block. Engelhard Hall will be the last building on the left before crossing University Avenue. Bove Auditorium is on the first floor.

6.3 Getting Around Newark: Newark Light Rail

Both services below are a short (less than 5 minute) walk from the Robert Treat Hotel. The Grove Street service is found at the Military Park station, while the Broad Street service is found at the NJPAC/Center Street station.

Please note that you need to purchase a ticket *before* **boarding the subway cars, or there will be a heavy fine ($76 at last report).** There are ticket vending machines at the platform, and you need to validate your ticket with a time-stamp *before* you board to avoid the fine. The (downtown) fare on the Grove Street service (valid between Rutgers-Newark and Newark Penn Station) is $0.60. The fare on the remainder of the system, including the Broad Street Station service, is $1.25.

- **To get from Newark Penn Station to the Rutgers-Newark campus**:
  Take the service to either Branch Brook Park or Grove Street, and exit at the second station (Washington Street). When on the platform of the Washington Street Station,

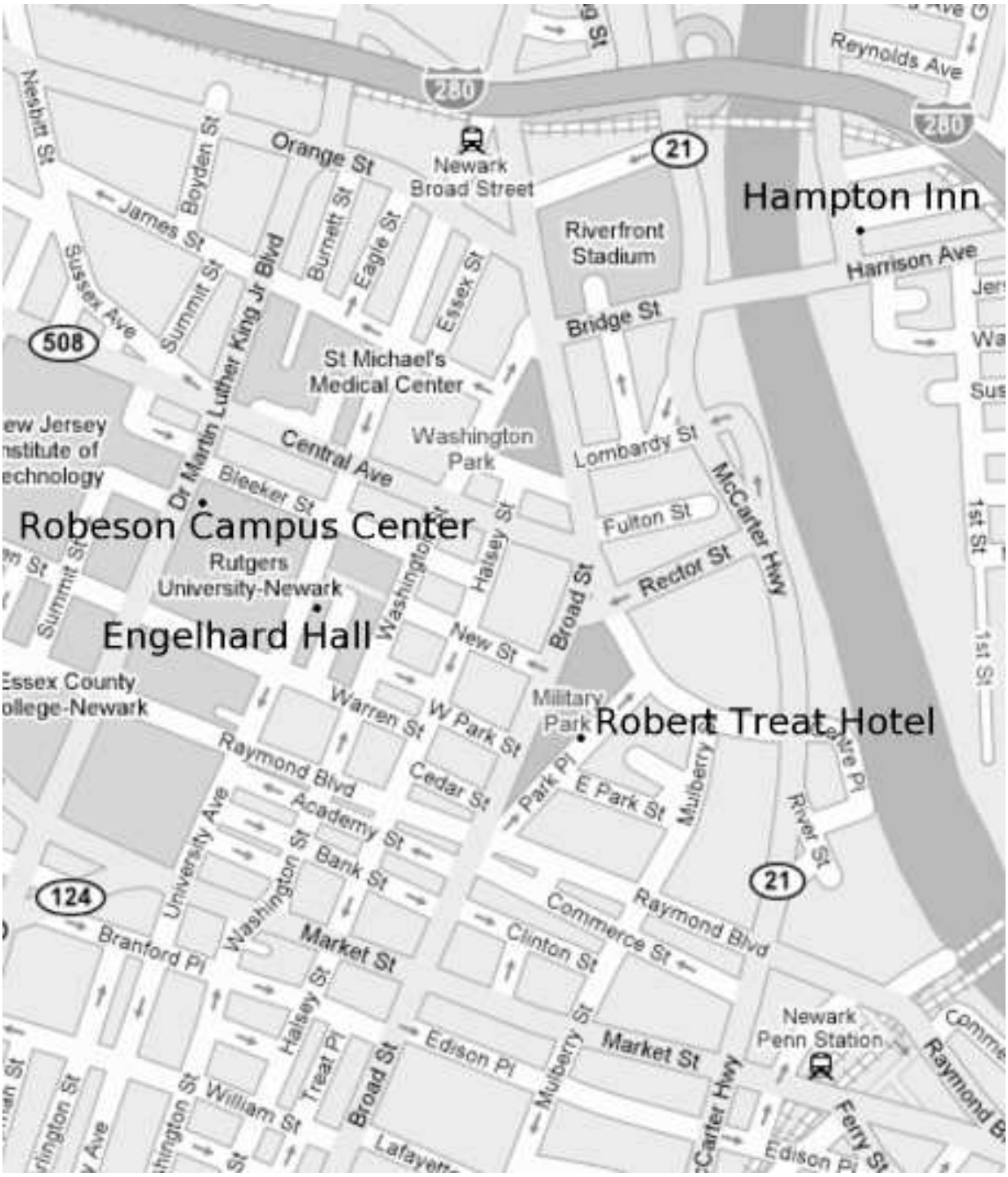

Figure 1: Map showing Robeson Campus Center, Engelhard Hall, Robert Treat Hotel, Hampton Inn, Penn Station (lower left), and Broad Street Station (top).

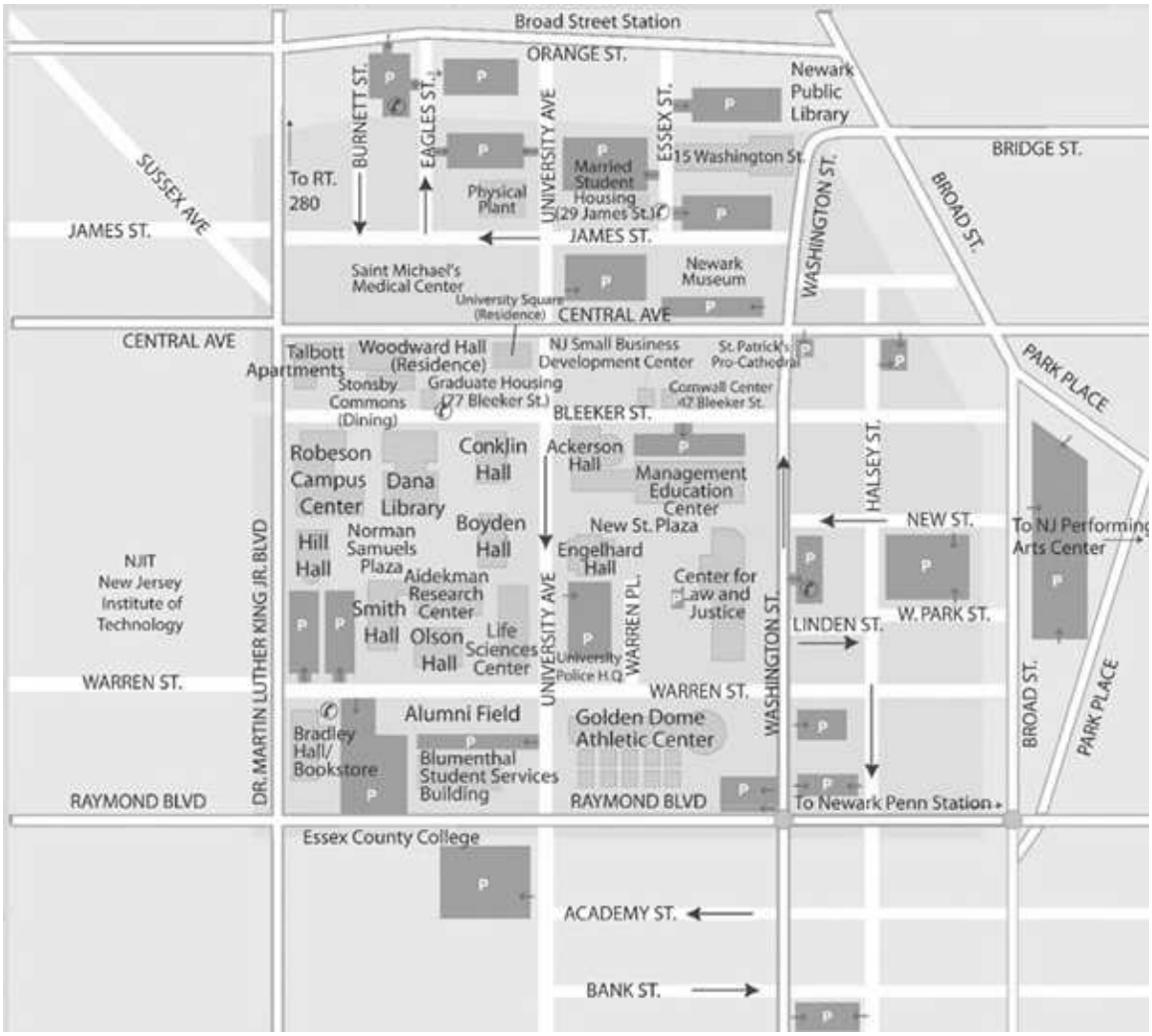

Figure 2: Campus Map for Rutgers University, Newark The workshop will be in Engelhard Hall. The banquet will be in Robeson Campus Center

walk to the left (in the direction that the subway is traveling) to the stairs or elevator. At the top of the stairs, turn right onto Raymond Boulevard, and then turn right again at the first traffic light onto University Avenue. Walk two blocks (north) to Engelhard Hall, the first building past the parking garage on the right.

- **To get from Newark Penn Station to the Broad Street Station**:
  This is for connections to other rail services offered by NJ Transit. Take the service to Broad Street Station. This service also connects to other Newark cultural institutions such as the Performing Arts Center, the Newark Museum and the Newark Public Library.

More information about the Newark Light Rail and other NJ Transit services is available at `www.njtransit.com`.

6.4 Parking on the Newark Campus for the Workshop

If you have already notified us of your intention to park on campus, you can park in either of two locations on campus and ask for a coupon from William Keigher at the workshop. The two locations are Parking Deck I, located at 200 University Avenue (between Bleeker Street and Warren Street), and Parking Deck II, located at 166 Washington Street (between Raymond Boulevard and Warren Street). Parking Deck I is available from 7:00 a.m. to midnight on both Thursday and Friday, while Parking Deck II is available on Thursday (only) from 7:00 a.m. until 7:00 p.m. On Saturday and Sunday, ample parking is available in many University surface parking lots.

For driving instructions and parking deck locations, please visit
`http://www.newark.rutgers.edu/maps/`

7 Rutgers and Newark, Other Information

7.1 Some useful numbers

- **Emergency:** 911
- **Medical emergency on campus:**
  911 or 5111 from any campus telephone, or 973-353-5111
- **Telephone operator:** 1766 from any campus telephone
- **Phone number inquiry:** 411
- **Department of Mathematics and Computer Science:**
  Phone: 973-353-5156, Fax: 973-353-5270
  Address: 216 Smith Hall, 101 Warren Street, Rutgers, The State University of New Jersey, Newark NJ 07102-1811
- **Campus Parking**: Phone 973-353-1839, Fax: 973-353-5873
  Address: 209 Blumenthal Hall, 249 University Avenue, Rutgers, The State University of New Jersey, Newark, NJ 07102

7.1.1 Police

- **Rutgers University Police Department (Newark):**
  Main phone: 973-353-5581
  Emergency (From University Extension): 5-111 or 80
  Address: 200 University Ave., Newark, NJ 07102
  http://nwkpolice.rutgers.edu/
- **Newark Police Department:**
  Main numbers: 973-733-6000
  Address: 31 Green Street, Newark, NJ 07102

7.1.2 Hospitals

- **Rutgers University Health Services Office**
  Blumenthal Hall, Room 104, 249 University Avenue, Newark, NJ 07102
  Phone: 973-353-5231

- **St Michael's Medical Center**
  268 Martin Luther King Jr Blvd, Newark, New Jersey 07102-2011, Phone: 973-877-5481

7.2 Newark Visitor Information

- Newark Museum (evening music), 49 Washington St., (973) 596-6550

- New Jersey Performing Arts Center (NJPAC) (performing arts/music), One Center Street, Newark, NJ 07102 (next to Robert Treat), 888-GO-NJPAC

- Ferry St. (main Ironbound street) — Ferry St. is known as an area destination for nightlife — many venues are located along or near the street.

- Newark Symphony Hall (performing arts/music/comedy), 1020 Broad St.
  Phone: 973-643-4550.

- Dining options will be listed the welcoming package for Workshop participants.

For additional visitor information, visit www.gonewark.com.

7.3 Internet

The computer lab is located in Room 311-313 at Engelhard Hall. Their hours of operation are M-Th 9am-7pm and Fri. 9am-5pm. Additional computers are also available at the Dana Library located at 185 University Ave. Their hours are M-Th 8am-12am and Fri. 8am-7pm.

8 Between Newark and Stevens Institute of Technology

8.1 By Conference Shuttle

A shuttle service will run from the Robert Treat Hotel and Hampton Inn (Newark) to Stevens Institute of Technology (Hoboken) on both Saturday and Sunday morning. The first trip will depart from Robert Treat at 6:50 AM with a stop at Hampton Inn on its way to Hoboken. The second trip will be at approximately 7:30 AM. The travel time from the hotels to Stevens is estimated to be 20 minutes. There may be a third trip (at approximately 8:15 AM) if there is sufficient demand. There will be a sign-up sheet circulated on Friday at the Workshop, so be sure to sign-up for this service if you are interested. Shuttles are also planned from Stevens Institute of Technology to Newark hotels in the afternoons of Saturday and Sunday, tentatively to leave at noon and at 5:30pm.

Figure 3: Hoboken map showing Hoboken Station and Burchard Building of Stevens Institute of Technology.

8.2 By Guided Public Transportation

Bill Keigher will be at the Robert Treat Hotel on both Saturday and Sunday morning to lead a group of those wanting to use public transportation from Newark to Stevens. We will depart promptly from the hotel at 6:30 AM to be able to catch the PATH train at 7:00 AM at Newark Penn Station. That trip will allow us to get to the AMS meetings in time to register and see the first session at 8:00 AM.

8.3 By Public Transportation on Your Own

To walk to Newark Penn Station, from the front entrance of the Robert Treat Hotel, turn left onto Park Place. Walk one block and turn left onto Raymond Boulevard. Walk three blocks to Newark Penn Station. See Figure 1 on page 12 for an area map. Estimated walking time is 12 minutes.

When at Newark Penn Station, there are several options to get to Hoboken Station.

- The most direct option is to take a NJ Transit train directly to Hoboken Station. Trains leave (usually from Track 1, but check the departure board) on Saturday and Sunday mornings at 6:15, 9:15 and 11:15. Travel time is 20 minutes. The fare is $3.50 one-way and $6.25 round trip. Be sure to purchase tickets before boarding the train.

- Another option is to take the PATH train. Trains usually leave from a platform adjacent to Track 1, but check for information about alternate departure locations while on the Track 1 platform. The one-way fare is $1.50; round trip is $3.00. After 7:00 AM, PATH trains depart every 15 minutes at :00, :15, :30 and :45; before 7:00 AM service is half-hourly. Take the PATH train two stops to Journal Square (in Jersey City, travel time is 11 minutes). At the Journal Square station, transfer (across the platform) to the 33rd St. train. The 33rd St. train departs every 15 minutes (after 7:00 AM) at :16, :31, :46, and :01. Take the 33rd St. train to the third stop (Hoboken) and detrain there (travel time from Journal Square to Hoboken is 13 minutes). More detailed information about PATH schedules can be found at http://www.panynj.gov/CommutingTravel/path/html/time.html.

- A less desirable option for travel from Newark Penn Station to Hoboken Station is to take a NJ Transit train bound for New York, and transfer at Secaucus (the first stop, but be sure to check that the NY bound train stops at Secaucus). Transfer to the lower level to a Hoboken bound train. Usually there are several trains each hour, but the transfer waiting time at Secaucus can be as long as 45 minutes. More detailed information about NJ Transit train schedules can be found at `http://www.njtransit.com/sf_tr_schedules.shtml`.

Once at Hoboken Station, exit the station on the side closest to Track 1 (on Observer Highway). Cross the street, and walk north (parallel to Hudson River) on Hudson Street to Fifth Street (7 blocks). Turn right on Fifth Street, and walk one block to River Street. Turn left onto River Street; the Burchard Building will be the second building on the left. A map is given in Figure 3 on page 16. Estimated walking time is 10 minutes.

9 AMS Special Session on Differential Algebra

9.1 Special Session Schedule

All talks for the Special Session on Differential Algebra will be given in in Room 118, Burchard Building which is at the corner of Sixth St and River St (*Building* 4 *in* Figure 4 *on page* 20).

Saturday, April 14, 2007

8:00 a.m.	B. Heinrich Matzat	Differential Equations and Frobenius Structures
8:30 a.m.	Andy R. Magid	Subfields of the Complete Picard–Vessiot Closure of a Differential Field
9:00 a.m.	Alexandru Buium,* Santiago Simanca	Arithmetic Partial Differential Equations
9:30 a.m.	Marius van der Put	Analytic q-Difference Equations, Universal Rings and Universal Galois Groups
10:00 a.m.	Elie Compoint, Anne Duval*	Local Differential Galois Group and Adjoint Representation
10:30 a.m.	Lourdes Juan,* Andy R. Magid	Differential Central Simple Algebras and Non-commutative Picard-Vessiot Cocycles
2:30 p.m.	David Harbater, Julia Hartmann*	Patching and Differential Galois Groups
3:00 p.m.	Charlotte Hardouin	Iterative q Difference Galois Theory
3:30 p.m.	Alexey Ovchinnikov	Tannakian Formalism for Linear Differential Algebraic Groups
4:00 p.m.	Claude Mitschi	A Generalization of the Riemann-Hilbert Problem
4:30 p.m.	Lucia Di Vizio	Borel-Laplace Summation of q-Series and Confluence
5:00 p.m.	Eugueny V. Pankratiev	Standard Bases in Differential Algebra

* speaker

Sunday, April 15, 2007

8:00 a.m.	Primitivo Belén Acosta-Humánez	Galois Theory and Spectral Theory
8:30 a.m.	Franz Winkler	Gröbner Bases in Difference-Differential Modules and Their Applications
9:00 a.m.	Oleg Golubitsky	Canonical Representation of Radical Differential Ideals
9:30 a.m.	Arne Ledet	PGL_3 as a Differential Galois Group
10:00 a.m.	Yang Zhang	Factorization in Skew Polynomial Rings
10:30 a.m.	François Ollivier	Jacobi's Work on Normal Forms of Differential Systems
2:30 p.m.	Alexander B. Levin	Dimension of Difference Field Extensions
3:00 p.m.	Wai Yan Pong,* Matthias Aschenbrenner	A Theorem of Sit
3:30 p.m.	Wenyuan Wu,* Greg Reid	Symbolic-Numeric Computation of Implicit Riquier Bases for PDE
4:00 p.m.	Dmitry Trushin	Spectra of Rings Differentially Finitely Generated over a Subring
4:30 p.m.	Jonathan Alexander Aïdan	Symplectic Properties of the Space of Differential Equations in the Space of Logarithmic Systems
5:00 p.m.	Alexandre Rambaud	O-minimality and Quantifier Elimination in Some Non Quasi-analytic Classes

* speaker

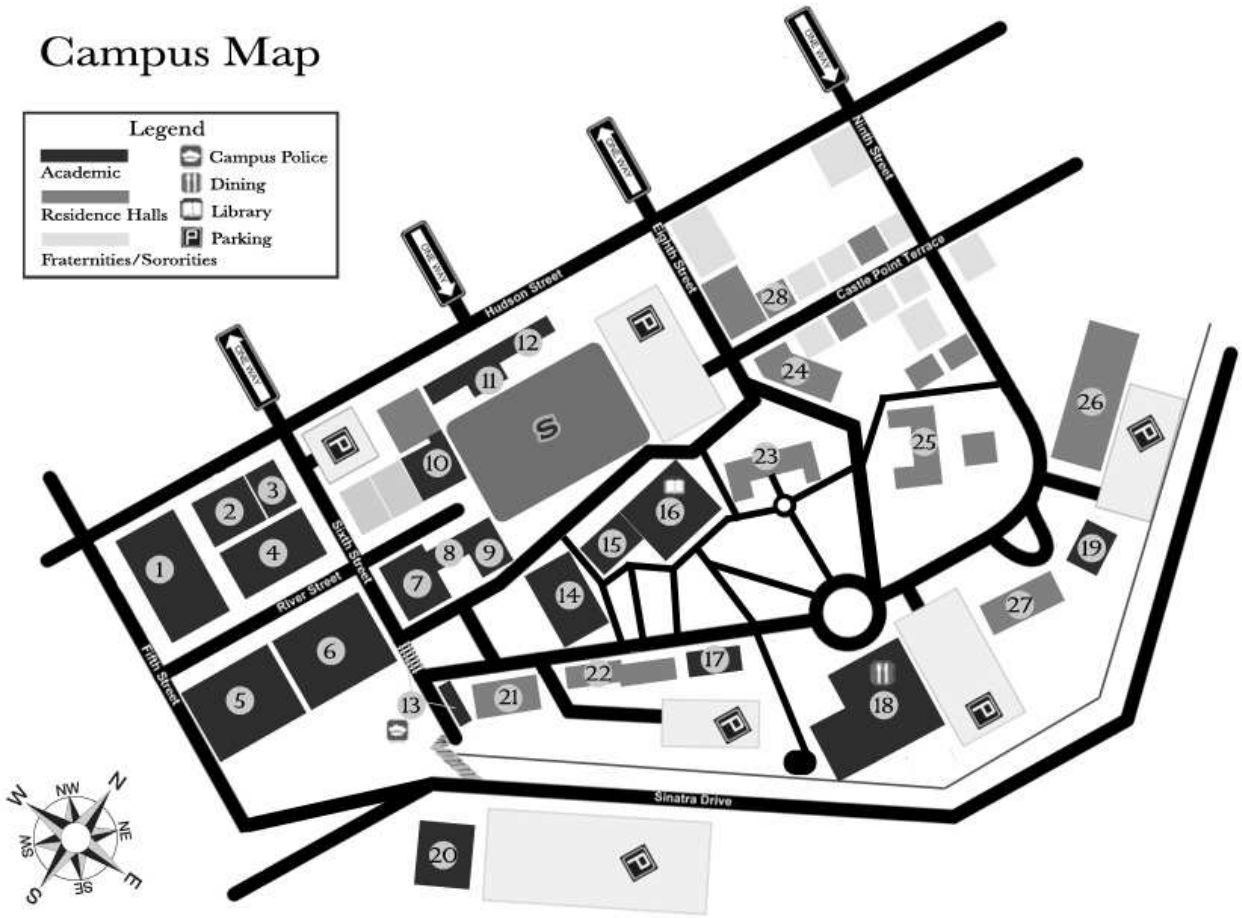

Figure 4: Campus Map for Stevens Institute of Technology. The Special Session will be in Room 118 of Burchard Building (Building 4).

9.2 Location and Registration

The AMS Eastern Section meeting will take place on Saturday, April 14, and Sunday, April 15, 2007, at Stevens Institute of Technology, in Hoboken, New Jersey. The Special Session on Differential Algebra and Related Topics will be held in Room 118, Burchard Building, beginning at 8:00 a.m. each day. A campus map is given above.

The registration will be in Room 124, Burchard Building. Invited addresses will take place in Room 118, Burchard Building. Registration will be open on Saturday from 7:30 a.m. to 4:30 p.m. and on Sunday from 8:00 a.m. to noon.

Registration fees (payable on site only) are: $40 for AMS or CMS members; $60 for non-members; $5 for emeritus members, students, or unemployed mathematicians. Fees are payable by cash, check, VISA, MasterCard, Discover, or American Express.

See Section 6 for information on transportation between Newark and Stevens Institute of Technology.

9.3 Parking at Stevens Institute of Technology for AMS Meeting

On Saturday and Sunday, parking at Stevens Institute of Technology is available for visitors only on the River Lot (next to Building 20 on map, Figure 4 on page 20). Every car must have a temporary permit tag, obtainable from Wesley J. Howe Center Visitor's Information Desk (Building 18 on map). While you are there, you may park temporarily in the traffic circle in front of the building. (Campus Police) Phone: (201)-216-5105.

9.4 Hoboken and New York Visitor Information

9.4.1 Campus Police for Stevens Institute of Technology

The Campus Police Department is located in the Gatehouse, east side of Sixth Street gate entrance to the Campus. Police are available 24 hours a day 7 days a week, and may be reached by telephone at 201-216-5105.

9.4.2 Hoboken

Visitor's Information Desk at Stevens Institute of Technology is in the Wesley J. Howe Center (Building 18 on map, Figure 4 on page 20). All lectures are given in either Edwin A. Stevens Hall (Building 1 on map) or Burchard Building (Building 4 on map). The web site `www.hobokeni.com` seems like a good source of Hoboken cultural events and other information.

9.4.3 New York City

The Official New York City Visitor Information Center: 810 Seventh Avenue, between 52nd and 53rd streets; Phone: 212-484-1222, www.nycvisit.com
Open Monday to Friday 8:30 to 6, Saturday and Sunday 9 to 5 Take the B, D, E to Seventh Avenue; the N, R, S, Q to 57th Street; or the 1, 9 to 50th Street