

COVER PAGE

INSTITUTION: Indiana University–Purdue University Indianapolis (IUPUI)

CAMPUS: Indianapolis

COLLEGE: Purdue School of Science

DEPARTMENT/SCHOOL: Mathematical Sciences

DEGREE PROGRAM TITLE: Ph.D. in Mathematical Sciences

SUGGESTED CIP CODE: 27.0101


PROJECTED DATE OF IMPLEMENTATION: January, 2016

NEW DEGREE PROGRAM PROPOSAL SIGNATURE PAGE

Degree Title: Ph.D. in Mathematical Sciences

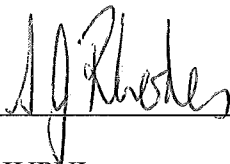
Name of academic unit offering the new degree: Purdue School of Science, IUPUI

Include signatures from all involved programs:



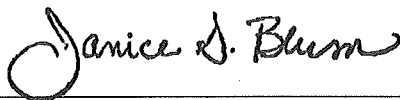
Joseph Rosenblatt, Professor and Chair
Department of Mathematical Sciences, IUPUI

10/11/15
Date



Simon Rhodes, Dean
Purdue School of Science, IUPUI

9/28/15
Date



Janice Blum
Associate Vice Chancellor for Graduate Education, IUPUI

10/11/15
Date

Approval Recommended by the Graduate Council

Date

M.J.T. Smith
Dean of the Graduate School

Date

Debasish (Deba) Dutta
Provost

Date

**Executive Summary for an Independent Ph.D. Program
in the Mathematical Sciences
on the Indiana University-Purdue University Indianapolis Campus
in the Department of Mathematical Sciences**

The Department of Mathematical Sciences at IUPUI is proposing the establishment of a site-approved, independent Ph.D. program in the Mathematical Sciences. The current Ph.D. program has operated successfully for many years under a Memorandum of Understanding with Purdue University West Lafayette (PUWL). The new program will complement the vigorous research program in the Department of Mathematical Sciences on the IUPUI campus and will strengthen the ability of the Department to compete nationally for the best faculty and students. The Department has strong research groups among its faculty in pure mathematics, applied mathematics, and statistics and biostatistics, that in a number of ways closely aligns it with the IUPUI campus emphasis on biomathematics and biomedical sciences, and with the IUPUI designation as the “Life and Health Sciences Campus” within the Indiana University System. Increasing the number of Ph.D. graduates is a central goal of the IUPUI strategic plan, adopted in 2013. There is also a clear alignment of this proposal with the State of Indiana’s economic development priorities related to the need for professionals trained in the mathematical sciences both as researchers and as teachers.

As stated above, the proposed program does not represent a new training program, but rather a new, independent status for an existing training program that has operated successfully for 22 years. Moreover, this program has operated with a considerable degree of autonomy for the last decade under the Memorandum of Understanding (MOU) between the Department of Mathematical Sciences at IUPUI and the Department of Mathematics at PUWL. Currently, students take all coursework and qualifying examination, Advanced Topics, and Preliminary Examinations in Indianapolis, and conduct their research with IUPUI faculty mentors and advisors. Furthermore, the current MOU has the admission, termination and Plan of Study decisions made by the Department of Mathematical Sciences at IUPUI. The proposed new program structure follows the current structure for graduate student education in the Department of Mathematical Sciences and the School of Science at IUPUI as a whole, using the academic standards of the Purdue University Graduate School. The proposal for an independent Ph.D. program in the mathematical sciences will allow the Ph.D. program in the Department of Mathematical Sciences at IUPUI to grow in ways that best support student success and allow it to be tailored appropriately over time to the particular research strengths of its faculty members.

Since this proposal is, in effect, a petition to rename and site-approve a 22-year ongoing activity, no new resources are needed to implement it: the faculty and staff necessary to conduct this degree program are already in place.

Program Description
Ph.D. in Mathematical Sciences
Indiana University–Purdue University Indianapolis (IUPUI)

1. Characteristics of the Program

- a. *Campus Offering Program*: Indiana University–Purdue University Indianapolis
- b. *Scope of Delivery (Specific Sites or Statewide)*: IUPUI
- c. *Mode of Delivery (Classroom, Blended or Online)*: Classroom, independent study
- d. *Other Delivery Aspects (Co-ops, Internships, Clinical, Practica, etc.)*:
Participation in research
- e. *Academic Unit(s) Offering Program*: IUPUI School of Science, Purdue University Graduate School

2. Rationale for Program

- a. *Institutional Rationale (Alignment with Institutional Mission and Strengths)*

This proposal is to establish a site-approved, independent Ph.D. program in the Department of Mathematical Sciences at IUPUI. The Department of Mathematical Sciences at IUPUI has a successful track record starting 22 years ago in training doctoral students under the aegis of the Department of Mathematics at Purdue University West Lafayette (PUWL). The new program will complement the vigorous research program in the Department of Mathematical Sciences on the IUPUI campus and will strengthen the ability of the Department to compete nationally for the best faculty and students. The Department has strong research groups among its faculty in pure mathematics, applied mathematics, and statistics and biostatistics, that in a number of ways closely aligns it with the IUPUI campus emphasis on biomathematics and biomedical sciences, and with the IUPUI designation as the “Life and Health Sciences Campus” within the Indiana University System. Increasing the number of Ph.D. graduates is a central goal of the IUPUI strategic plan, adopted in 2013. There is also a clear alignment of this proposal with the State of Indiana’s economic development priorities related to the need for professionals trained in the mathematical sciences both as researchers and as teachers.

The program serves several critical needs:

- (1) supporting and enhancing the research mission of the Department of Mathematical Sciences,
- (2) increasing the profile of the Department nationally,
- (3) enhancing faculty recruitment,
- (4) creating an environment in which undergraduate students have an opportunity to be immersed in cutting-edge research in the mathematical sciences, and

(5) producing doctoral graduates with rigorous classroom training in contemporary mathematical sciences and definitive experience in research that advances mathematical science (particularly in areas relevant to mathematical physics, dynamical systems, applied mathematics focusing on biomathematics modeling, and statistical and biostatistics methods in the physical and life sciences).

The Department of Mathematical Sciences at IUPUI has developed research strengths as a consequence of its location on the IUPUI campus and the opportunities afforded by collaborations with the IU School of Medicine, other departments in the School of Science, and local life sciences private sector enterprises (for example, Dow, Lilly, Roche, and Teledoc). Indeed, the Department of Mathematical Sciences at IUPUI not only has an excellent track record of national level funding from the National Science Foundation (NSF) (in pure mathematics, statistics, and applied mathematics) and now the Simons Foundation too, but has applied mathematics faculty who have obtained funding from the National Institutes of Health (NIH) through their work in neuroscience and biomathematics modeling.

The Department of Mathematical Sciences has a strong and talented faculty with research programs covering many important areas in pure and applied mathematics, as well as in statistics. Currently, these areas of strength include: Modern Analysis and Geometry, Dynamical Systems, Mathematical Physics, Applied and Computational Mathematics, Statistics and Biostatistics, and Mathematics Education. The diversity of the Department's faculty research mirrors the intellectual trends of the mathematical sciences in a time of a burgeoning of applications in many areas of science, medical sciences, and business. Reflective of this, the Department hosts a number of research-related activities, such as seminars, colloquia and mini-conferences. In addition to the regular Friday Departmental Colloquiums, there are a number of other weekly seminars ongoing in the Department such as Modern Analysis and Geometry Seminar; Dynamical Systems Seminar; Mathematical Physics Seminar; Statistics Seminar; Operator Theory Seminar, Mathematical Neuroscience Seminar and Biomath Seminar. The Department also traditionally hosts the Fall Meeting of the *Wabash Extramural Modern Analysis Seminar* (September/October). These activities combined have helped create an intense research environment in the Department and allowed it to host over the recent years a large number of top research mathematicians with national and international reputations, of whom many are closely interacting with our faculty on research-related matters.

As stated above, the proposed program does not represent a new training program, but rather a new, independent status for an existing training program that has operated successfully for 22 years. Moreover, this program has operated with a considerable degree of autonomy for the last decade under the Memorandum of Understanding (MOU) between the Department of Mathematical Sciences at IUPUI and the Department of Mathematics at PUWL. Currently, students take all coursework and qualifying examination, Advanced Topics, and Preliminary Examinations in Indianapolis, and conduct their research with IUPUI faculty mentors and advisors. Furthermore, the current MOU has the admission, termination and Plan of Study decisions being made by the Department of Mathematical Sciences at IUPUI. The

proposed new program structure follows the current structure for graduate student education in the Department of Mathematical Sciences and the School of Science at IUPUI as a whole, using the academic standards of the Purdue University Graduate School. The proposal for an independent Ph.D. program in the mathematical sciences will allow the Ph.D. program in the Department of Mathematical Sciences at IUPUI to grow in ways that best support student success and allow it to be tailored appropriately over time to the particular research strengths of its faculty members.

- b. *State Rationale “Reaching Higher, Achieving More calls for institutions that advance the specific mission and strengths of each institution.”*

The mission and vision statements of the IUPUI Campus are:

Indiana University–Purdue University Indianapolis (IUPUI), a partnership between Indiana and Purdue Universities, is Indiana’s urban research and academic health sciences campus.

IUPUI’s mission is to advance the state of Indiana and the intellectual growth of its citizens to the highest levels nationally and internationally through research and creative activity, teaching and learning, and civic engagement.

By offering a distinctive range of bachelor’s, master’s, professional, and Ph.D. degrees, IUPUI promotes the educational, cultural, and economic development of central Indiana and beyond through innovative collaborations, external partnerships, and a strong commitment to diversity.

Our vision: To be a leading urban research institution recognized for the success of its students, its advances in health and life sciences, and its intellectual, economic, and cultural contributions to the well-being of the citizens of Indianapolis, the state of Indiana, and beyond. Indianapolis, the state of Indiana, and beyond.

It should be clear that the Department of Mathematical Sciences at IUPUI Ph.D. program directly addresses multiple aspects of this mission and vision, including the development of research of all types (including research in the health and life sciences via the Applied Mathematics and Statistics programs in the Department). The Department fosters a research atmosphere that creates a distinctive range of doctoral degrees and the economic development of the central Indiana region. This proposal will advance IUPUI campus goals of increasing the number of doctoral degree graduates, strengthening the connections of mathematical sciences with the physical and life sciences research at IUPUI, and forging partnerships with national and international research at a full range of academic and private sector institutions.

- c. *Evidence of Labor Market Need*
 - i. *National State, or Regional Need.*

Employment demand for doctoral graduates in mathematical sciences is steady or increasing. The American Mathematical Society (AMS) releases an annual report on the demand for trained mathematicians. See

<http://www.ams.org/profession/data/annual-survey/docsgrtd>

for a complete history and, in particular, for the most current report available online, see

<http://www.ams.org/profession/data/annual-survey/2014Survey-Prelim-NewDoctorates.pdf>

For example, the following data is provided: In 2013-2014, the United States employed a total of 1,228 new mathematics Ph.D. graduates; data is then provided by Type of Employer: a) Ph.D. granting institutions 346 (28%) b) Business & Industry 325 (26%) c) Masters and Bachelors and 2-year Colleges 228 (19%), d) Other academic and research institutes 205 (17%), e) Government 64 (5%), f) Statistics and biostatistics 60 (5%). Note: f) represents the number of Ph.D.s in mathematics who take employment as statisticians or biostatisticians, but the percentage for this would be higher with Ph.D.s where there was an emphasis in statistics like some of the students earning Ph.D.s in the Department of Mathematical Sciences at IUPUI.

In addition, information on salaries can be obtained at

<http://www.ams.org/profession/data/annual-survey/2013Survey-StartSal.pdf>

For example, median salaries for new Ph.D.s in mathematics for 2013 are summarized as follows: for academic/teaching positions \$53,000-\$60,000 depending on the type of institution and whether it is 9/10/12 month salary, for government employment \$87,000, and for private sector employment \$100,000.

ii. *Preparation for Graduate Programs or Other Benefits.*

The Ph.D. is a terminal degree, but a large proportion of Ph.D. graduates in mathematical sciences will go on to postdoctoral training in their area of study and/or in related fields. There are many opportunities for graduates with a Ph.D. in mathematics, including the public sector (e.g., NSA and the Census Bureau, or other government agencies), the private sector (e.g., internet and communications companies like Google, finance in companies like Bank of America, actuarial science in companies like One America, risk analysis positions in banking firms, and investment companies like Renaissance Technologies). Some graduates will use their training in other careers entirely such as law and business and will seek advanced degrees in these areas.

iii. *Summary of Indiana DWD and/or U.S. Department of Labor Data*

Indiana Department of Workforce Development (DWD) data do not specifically address demand for doctoral graduates, but overall demand in the mathematical sciences in the state is strong. For example, DWD predicts growth in employment for postsecondary teachers to be up 18% in the next 10 years, for Ph.D. level computer and mathematical scientists to be up anywhere

from 25% to 35% in the next 10 years, for actuaries to be up 32% in the next 10 years, and financial analysis such as what mathematical scientists can do to be up 15% in the next 10 years. The state is unlikely to be able to achieve significant growth in high priority sectors such as the mathematical sciences without access to a pool of individuals trained to the doctoral level in mathematics and statistics. Overall demand for college graduates in these economic sectors will drive sustained demand by public and private institutions of higher education in the state for doctoral graduates to serve their instructional and research needs.

iv. National, State or Regional Studies

National reports such as ones provided by the AMS and the American Statistical Association (ASA) show a high proportion of doctoral degree graduates in the mathematical sciences are employed in research careers, either in academic institutions or in other settings (the public or the private sectors). The fraction of graduates not in the labor force remains very low. This is in the context of a significant increase in the number of Ph.D.'s granted in these fields over the last 20 years. Thus, the job market for graduates from this program is currently, and will remain, robust.

v. Surveys of Employers or Students and Analyses of Job Postings

The track record of IUPUI mathematical sciences Ph.D. graduates in advancing their careers is clear evidence of demand for the skills. This is documented in Appendix A. There is a high expectation that the current group of 40 Ph.D. students on support will have similar successes in their careers.

vi. Letters of Support

See Appendix D.

3. Costs of and Support for the Program

a. Costs

- *Faculty and Staff*

The Department of Mathematical Sciences has 49 faculty members including the tenure track faculty, the specialized faculty, and the lecturers. There are also two academic advisors, an office manager, and two office staff. In particular, the Department has 32 tenure track faculty with regular appointments in the Purdue University Graduate School and who are currently able to serve on graduate committees and to mentor students. They will constitute the graduate faculty for the new program. No new faculty positions are required to establish the independent program.

- *Facilities*

The program will be supported by teaching and research facilities that currently exist on the IUPUI campus. Besides office space for the faculty

members, there are four large rooms (three in the School of Science LD building) where the Ph.D. students have shared office space with individual desks and computer access.

- *Other Capital Costs (e.g., Equipment)*

Student research will be supported by existing capital equipment (such as computers, copiers, etc.) in the Department of Mathematical Sciences and the School of Science, or by equipment purchased with funds secured by research grants.

- b. Support*

- *Nature of Support (New, Existing, or Reallocated)*

Since this is a continuation of an ongoing program, only existing funding will be used.

- *Special Fees above Baseline Tuition*

The Mathematical Sciences Ph.D. program will have the same tuition and fees as the other IUPUI School of Science graduate programs.

4. Similar and Related Programs

- a. List of Programs and Degrees Conferred*

- *Similar Programs at Other Institutions*

There are currently three other mathematics Ph.D. programs in Indiana, besides the one at IUPUI, with the largest being at Indiana University Bloomington (IUB) and Purdue University West Lafayette (PUWL), the program through which we are now operating. There are Ph.D. programs at the University of Notre Dame in the Department of Mathematics and the Department of Applied and Computational Mathematics and Statistics. Each of these programs have a focus or flavor that makes them different in some ways to the others. The current program at IUPUI operated under the MOU with PUWL has a full range of possible Ph.D. work in the mathematical sciences: pure mathematics (including geometry, dynamical systems, and mathematical physics), applied mathematics (including neuroscience and biomathematics), statistics, and mathematical education. This allows Ph.D. students in the Department to work across lines of expertise rather easily because the relevant faculty experts are all in the same department.

The inclusion of faculty members whose domain of excellence is pure mathematics, applied mathematics, statistics, and mathematical education in the Department of Mathematical Sciences at IUPUI makes it unique in Indiana. Students seeking a Ph.D. degree in Mathematical Sciences at IUPUI start by taking courses and qualifying examinations that generally prepare them for the degree, and then take courses and do research that is focused in one of the areas of specialization of pure mathematics, applied

mathematic, statistics, and mathematical education. This process is different at the other universities offering Ph.D. degrees in Indiana. At PUWL, there is a strong Department of Statistics which is separate from the Department of Mathematics, while at Indiana University the Department of Statistics is smaller and still relatively new. Notre Dame University is different in that there is a separate Department of Applied and Computational Science and Statistics. When seeking a Ph.D. at these schools, a student must be admitted to the appropriate department that fits their planned specialization within mathematical sciences. But at IUPUI, a student could start their Ph.D. work with a plan to study in one area and then easily switch to another area of specialization because the Ph.D. degree with specializations are all within the IUPUI Department of Mathematical Sciences.

Within each of the departments offering Ph.D. degrees in mathematics or the mathematical sciences in Indiana, there are many differences in faculty interests and strengths leading to a divergence in the type of research that Ph.D. students pursue in the dissertation phase of their Ph.D. degree work. The Department of Mathematical Sciences at IUPUI has faculty with extensive expertise in areas of pure mathematics, applied mathematics, statistics, and mathematical education. One of the unique strengths and a focus area of the IUPUI Department of Mathematical Sciences is on health data sciences/biostatistics and biomathematics modeling (e.g. in neurosciences and vascular studies); this specialization is facilitated by having the IU Schools of Health Sciences located on the IUPUI campus.

The Department of Mathematical Sciences at IUPUI organizes research into broad areas and then delineates subareas within those as follows:

- Pure Mathematics: including algebra, and number theory, dynamical systems, mathematical physics, modern analysis and geometry;
- Applied and Computational Mathematics: biomathematics modeling in neuroscience, vascular dynamics, complex non-linear dynamics in biological systems, (digital) signal processing, phase retrieval, and a variety of inverse problems in imaging sciences;
- Statistics and Biostatistics: applied probability, Bayesian statistics, biostatistics, design of experiments, empirical likelihood, high dimensional statistical inference, mathematical statistics, reliability theory, sequential analysis, spatial statistics, and time series; and
- Mathematics Education: STEM issues in middle and secondary schools, and STEM education at the university level.

What makes the mathematical sciences Ph.D. program at IUPUI unique and worthwhile is its strong connections with the medical and life sciences theme of the research being done at IUPUI, in part as a result of the presence of the IU Schools of Medicine, Dentistry, and Nursing on the IUPUI campus. The Department of Mathematical Sciences at IUPUI has a

long track record of extramural funding from the NSF, and in recent years, also from the Simons Foundation. Notably, a number of the Department's faculty members are supported by the NIH because of their interdisciplinary work in applied mathematics with connections to the health and medical sciences.

- *Related Programs at the Proposing Institution*

The most similar program at the proposing institution is the current Ph.D. program in Mathematical Sciences that operates under an MOU with PUWL. This proposed Ph.D. program will continue that successful Ph.D. program with minor modifications.

b. List of Similar Programs Outside Indiana

There are too many mathematical sciences Ph.D. programs to list in this proposal. There are programs at most research universities, since a doctoral program is an important complement to a high level of research activity. For example, the AMS lists the following:

The doctorate-granting mathematics departments at **public institutions** are grouped as follows:

- The [Public Large Group](#) consists of the 26 departments with the highest annual rate of Ph.D.s ranging between 7.0 and 24.2 per year.
- The [Public Medium Group](#) consists of the 40 departments with annual rate of Ph.D.s ranging between 3.9 and 6.8 per year.
- The [Public Small Group](#) consists of the remaining 64 departments.

The doctorate-granting mathematics departments at **private institutions** are grouped as follows:

- The [Private Large Group](#) consists of the 24 departments with the highest annual rate of Ph.D.s ranging between 3.9 and 19.8 per year.
- The [Private Small Group](#) consists of the remaining 28 departments.
- The doctorate-granting [Applied Mathematics Group](#) consists of 31 applied mathematics departments. The doctorate-granting [Statistics Group](#) consists of 58 statistics departments. The doctorate-granting [Biostatistics Group](#) consists of 44 biostatistics departments.

c. Articulation of Associate/Baccalaureate Programs

Not applicable.

d. Collaboration with Similar or Related Programs on Campus

As discussed in Section 4a above, we currently operate our Ph.D. program under a Memorandum of Understanding (updated in April 2015) with Purdue

University West Lafayette (PUWL). This provides a full range of possible Ph.D. work for our students in the mathematical sciences. We also have a collaborative arrangement with the BioStatistics Ph.D. program, now held in the School of Public Health. Our faculty mentor and advise several BioStatistics Ph.D. students each year. Additionally, several of our Applied Math faculty work closely with faculty and graduate students in the School of Medicine Neuroscience, Medical Imaging and Ophthalmology areas.

5. Quality and Other Aspects of the Program

a. Credit Hours Required/Time to Completion

- *Credit hours required for the program and how long a full time student will need to complete the program.*

Ph.D. students in the Department of Mathematical Sciences at IUPUI take their course work on the IUPUI campus. The minimum number of credits required to complete the Ph.D. degree is 90 credit hours, comprised of coursework and research hours (Math 69900) under the supervision of the student's mentor. Students may choose to pursue a Ph.D. degree with a specialization in pure or applied mathematics, statistics or math education. For students directly admitted to the Ph.D. program, the total number of credit hours will typically comprise 90 hours of coursework (with up to 30 credit hours being applied from a M.S.) and a minimum of 18 credit hours of research.

Typically, graduate students enroll in nine credit hours of combined coursework and research each semester. The credit hour requirements for the Ph.D. can easily be completed in four years; accomplishing mandated research goals usually takes longer in the mathematical sciences, with five years being typical. Students may also transfer in up to 30 credit hours from a M.S. degree or up to 12 graduate non-degree credit hours toward the 90 credit hours of coursework required for the Ph.D. (contingent on faculty approval).

Sample Plans of Study are included as Appendix C.

b. Exceeding the Standard Expectations of Credit Hours

Not applicable.

c. Program Competencies or Learning Outcomes

- *List the significant competencies or learning outcomes that students are expected to master.*

Upon completion of the Ph.D. in Mathematical Sciences, students should be able to:

- Design and conduct well-conceived, significant research projects in a sub-discipline of mathematical sciences that can advance knowledge in the field.
- Critically analyze and evaluate ideas, information, or data created by themselves or others and make judgments about the quality and significance of these.
- Effectively communicate the results of research in written form to qualified individuals in the mathematical sciences via publications in the scientific literature.
- Write effective proposals to secure support for research projects in the mathematical sciences.
- Orally communicate research results to a professional audience and engage in dialogue with other researchers in the field.
- Demonstrate in-depth knowledge of scientific literature in the chosen field of inquiry and use this knowledge effectively to inform the selection of research questions and the approach to be taken.
- Conceive new ideas or new ways of understanding mathematical questions.
- Demonstrate an appreciation of ethical concerns in mathematical research and the importance of research integrity.

d. Assessment

Assessment of progress toward achieving the competencies expected of Ph.D. graduates will be assessed at multiple stages during students' careers:

- Coursework is assessed through examination, oral presentation and written reports.
- Students are assessed on their knowledge in one of the sub-disciplines of biology with a written qualifying exam set by the graduate faculty and taken at the end of the first year.
- In a preliminary exam at the end of the second year, students present and defend a written proposal of the work planned for inclusion in the doctoral dissertation. The student's advisory committee of four or more graduate faculty, including the research mentor, oversees the preliminary exam.
- Students meet at least annually with their advisory committee to review progress toward completion of the research that will be included in the dissertation.
- Students submit the final dissertation to the advisory committee for approval and are examined at an oral defense of their research by the advisory committee and the graduate faculty.

e. Licensure and Certification

Not applicable.

f. Placement of Graduates

Placement of graduates is indicated in the list of previous IUPUI Department of Mathematical Sciences Ph.D. students. Students have gone on to postdoctoral fellowships at prestigious universities and progressed to faculty positions in research institutions. Others have taken positions in the public or private sector. The employment profile of the Ph.D. graduates of the Department of Mathematical Sciences at IUPUI in many ways parallels the norms of the employment of Ph.D. graduates in the mathematical sciences in the United States as a whole. A list of former graduates is attached as Appendix A.

g. Accreditation

Accreditation is not available for Ph.D. programs in the mathematical sciences.

6. Projected Headcount and FTE Enrollments and Degrees Conferred

The Ph.D. program is projected to continue a steady growth consistent with the last five years. The intent will be to grow the Ph.D. program in the Department of Mathematical Sciences to be near to having 50 students total by the year 2020. Currently, there are 40 Ph.D. students in the program for fall 2015 (counting current students and new admissions). This planned growth will be coupled with a growth of the full-time tenure track faculty to 40, an increase by six positions with retirements and resignations taken into account. This will guarantee adequate capacity of a sufficient number of faculty mentors to support the larger Ph.D. program. Projections of growth past 2020 are dependent on the growth in the IUPUI overall student population and an increase in the Department of Mathematical Sciences tenure-track faculty lines. These two factors are difficult to predict at this time.

An aspect of the planning for the growth in the Ph.D. program is the balance of domestic versus international students. In AY 2014-2015, there were 31 full-time Ph.D. students with 25 being international and 6 being domestic (U.S. citizen and permanent resident). In fall 2015, there will be 39 full-time students, of whom 29 students are international and 10 are domestic. The emphasis will be placed of quality of students in the growth of the Ph.D. program to 50 students, but at the same time it will be a major goal to move the program to having a higher representation of domestic students, with parity being the target balance. The intent of this is to make the program better serve the needs of capacity for mathematical sciences graduate education in the U.S. for domestic students.

Here is a summary of what the balance of support for Ph.D. students has been over the last several years:

	# Supported	# Research Assistants	#Teaching Assistants	#Fellowships	Amount of Funding
2014- 2015	31	8	20	3	\$580,000
2013- 2014	31	6	23	2	\$566,249
2012- 2013	21	4	14	3	\$385,750

As a view of the planned growth of the Ph.D. program, see the table below showing the actual Ph.D. student enrollment numbers through 2015 (in black) and the projected enrollment numbers through 2020 (in red):

2004- 2005	2005- 2006	2006- 2007	2007- 2008	2008- 2009	2009- 2010	2010- 2011	2011- 2012
8	8	13	12	13	13	17	23
2012- 2013	2013- 2014	2014- 2015	2015- 2016	2016- 2017	2017- 2018	2018- 2019	2019- 2020
23	25	31	39	42	45	48	50

Note: The current operating policy in the Department of Mathematical Sciences at IUPUI is that a typical Ph.D. student is admitted with a commitment for five years of support through a fellowship, a teaching assistantship (TA), or a research assistantship (RA) depending on available resources and the student's academic achievements.

The present instructional capacity, in terms of the number of undergraduate courses and the number of undergraduate students, significantly exceeds what is necessary for there to be resources to support 12 additional graduate students using TA lines alone. In addition, there is a projection of growth in student enrollments at IUPUI in both the School of Science and the School of Engineering and Technology, and there is expected to continue to be high demand by undergraduate students in other Schools at IUPUI for mathematical science courses required for the various majors. Moreover, even now there is a need to regularly hire a number of part-time faculty each term to cover the instructional demand for mathematical sciences courses. Considering this alone, having additional graduate student TAs in place of some of these part-time faculty will allow for the support needed for the additional 12 graduate students planned in the total numbers of Ph.D. students over the next five years.

LIST OF APPENDICES:

- Appendix A: Admission Requirements, Curriculum Requirements, Sample Curriculum and Existing Program Curriculum
- Appendix B: Faculty: Areas of Specialization

Appendix C:	History and Size of the IUPUI Mathematical Sciences Ph.D. Programs
Appendix D:	Letters of Support
Appendix E:	Headcounts and Cost Projections

Appendix A: Admission Requirements, Curriculum Requirements, Sample Curriculum and Existing Program Curriculum:

We invite applications from individuals who have earned a B.S. in Math with at least a 3.0 GPA, or those with a strong mathematics background in the following courses: linear algebra, complex analysis, abstract algebra, real analysis, numerical analysis, partial differential equations, ordinary differential equations, mathematical statistics and probability.

The Ph.D. program requires the completion of at least 90 credit hours, and up to 30 credit hours from an M.S. degree may be applied, with approval from faculty advisors.

- **Ph.D. Math Admissions Requirements:**

1. **Official GRE general GRE test scores** are required for admission, with a GRE Math Subject test score being highly recommended.
2. Applicants whose native language is not English must demonstrate their **English proficiency** with one of the following options:
 - i) **Official TOEFL** score report that is no more than two years old with the following minimum scores:
 - 570 on the paper-based test
 - 230 on the computer-based test, or
 - 79 on the internet-based test, with sub-scores of:
 - Writing - 18
 - Speaking – 18
 - Listening – 14
 - Reading – 19
 - ii) **Official IELTS** (International English Language Testing System) score of at least 6.5.
 - iii) Completion of a post-secondary degree in a native-English speaking country or country recognized by [IUPUI for TOEFL exemption](#) within two years of enrollment date.
3. **Personal Statement:** 300-500 words on your professional development and academic goals.
4. **Resume/CV:** submitted to the department to account for any research experience the applicant may have.
5. **Supplemental Question Form:** submitted to the department to gather information about research interests, academic background, program specialization interests, and recruitment purposes.
6. **Three Letters of Recommendation:** submitted to the department by preferably faculty members who have worked directly with the applicant and can attest to his or her academic acumen.
7. **IUPUI Online Application**, with a fee of \$65.

8. **Official transcripts** sent directly to the department, and if the original document is not in English, the applicant must submit both a transcript in the original language as well as an English translation from the issuing university.
9. **Financial Statement (International applicants only):** students who are recommended for admission without financial support must submit documentation that he or she will be able to support his or her studies without university or departmental financial support.

- **Curriculum Requirements**

The minimum number of credits required to complete the Ph.D. degree is 90 credit hours, comprised of coursework and research hours (Math 69900) under the supervision of the student's mentor. Students may choose to pursue a Ph.D. degree with a specialization in pure or applied mathematics or statistics. For students directly admitted to the Ph.D. program, the total number of credit hours will typically comprise of 90 hours of coursework (with up to 30 credit hours being applied from a M.S.) and a minimum of 18 credit hours of research.

Typically, graduate students enroll in 9 credit hours of combined coursework and research each semester. The credit hour requirements for the Ph.D. can easily be completed in 4 years; accomplishing mandated research goals usually takes longer in the mathematical sciences, with 5 years being typical. Students may also transfer in up to 30 credit hours from a M.S. degree or up to 12 graduate non-degree credit hours toward the 90 credit hours of coursework required for the Ph.D. (contingent on faculty approval). For students directly admitted to the Ph.D. program, the total number of credit hours will typically comprise of 90 hours of coursework (with up to 30 credit hours being applied from a M.S.) and a minimum of 18 credit hours of research.

Usually, graduate students enroll in 9 credit hours of combined coursework and research each semester. The credit hour requirements for the Ph.D. can easily be completed in 4 years; accomplishing mandated research goals usually takes longer in the mathematical sciences, with 5 years being typical. Students may also transfer in up to 30 credit hours from a M.S. degree or up to 12 graduate non-degree credit hours toward the 90 credit hours of coursework required for the Ph.D. (contingent on faculty approval).

- **Sample Curriculum 1– Pure Mathematics**

Four Core Math Courses:

Introduction to Complex Variables I	MATH 53000
Real Analysis & Measure Theory	MATH 54400
Abstract Algebra	MATH 55300
Linear Algebra	MATH 55400

Advanced Electives:

Introduction to Biomathematics	MATH 59800
Dynamical Systems I	MATH 56700
Qualitative Theory of Differential Equations	MATH 52200

Introduction to Partial Differential Equations	MATH 52300
Dynamical Systems II	MATH 59800
Complex Dynamics	MATH 59800
Mathematical Physics I	MATH 57400
Boundary Value Problems: Diff Equations	MATH 52000
Mathematical Physics II	MATH 67400
Elementary Topology	MATH 57100

PLUS 30 Credits Applied from M.S. degree
PLUS 18 Research Credits

- **Sample Curriculum 2– Applied Mathematics**

Four Core Math Courses:

Introduction to Complex Variables I	MATH 53000
Real Analysis & Measure Theory	MATH 54400
Abstract Algebra	MATH 55300
Linear Algebra	MATH 55400

Advanced Electives:

Intro to Mathematical Stats	STAT 52800
Numerical Analysis	MATH 59800
Principles of Analysis II	MATH 54500
Complex Dynamics	MATH 59800
Introduction to Biomathematics	MATH 59800
Fluid Structure Interaction in Hemodynamics	MATH 59800
Introduction to Differential Geometry and Topology	MATH 56200
Introduction to Partial Differential Equations	MATH 52300
Continuum Mechanics I	MATH 59800
Continuum Mechanics II	MATH 59800

PLUS 30 Credits Applied from M.S. degree
PLUS 18 Research Credits

- **Sample Curriculum 3– Mathematical Statistics**

Four Core Math Courses:

Introduction to Complex Variables I	MATH 53000
Real Analysis & Measure Theory	MATH 54400
Abstract Algebra	MATH 55300
Linear Algebra	MATH 55400

Advanced Electives:

Applied Regression Analysis	STAT 51200
Design of Experiments	STAT 51400
Probability Theory	STAT 51900
Applied Multivariate Analysis	STAT 52400
Mathematical Statistics	STAT 52800
Time Series and Applications	STAT 52000
Sampling and Survey Techniques	STAT 52200
Categorical Data Analysis	STAT 52300
Elements of Stochastic Processes	STAT 53200
Introduction to Survival Analysis	STAT 53600

PLUS 30 Credits Applied from M.S. degree

PLUS 18 Research Credits

• **Existing Program Curriculum:**

*Intermediate Abstract Algebra	MATH 50500
Vector Calculus	MATH 51000
Linear Algebra with Applications	MATH 51100
Numerical Analysis	MATH 51400
*Advanced Discrete Mathematics	MATH 51800
Boundary Value Problems of Differential Equations	MATH 52000
Qualitative Theory of Differential Equations	MATH 52200
Introduction to Partial Differential Equations	MATH 52300
Introduction to Complex Analysis	MATH 52500
Principles of Mathematical Modeling	MATH 52600
Advanced Mathematics for Engineering and Physics II	MATH 52800
*Functions of a Complex Variable I	MATH 53000
Functions of a Complex Variable II	MATH 53100
Theoretical Mechanics	MATH 53500
Applied Math for Scientists and Engineers I	MATH 53700
*Real Analysis and Measure Theory	MATH 54400
Principles of Analysis II	MATH 54500
Introduction to Functional Analysis	MATH 54600
*Analysis for Teachers I	MATH 54700
Applied Math for Secondary School Teachers	MATH 54900
Applied Computational Methods II	MATH 55200

*Introduction to Abstract Algebra	MATH 55300
*Linear Algebra	MATH 55400
Applied Computational Methods I	MATH 55900
*Projective Geometry	MATH 56100
Introduction to Differential Geometry and Topology	MATH 56200
*Advanced Geometry	MATH 56300
Dynamical Systems I	MATH 56700
Elementary Topology	MATH 57100
Introduction to Algebraic Topology	MATH 57200
Mathematical Physics I	MATH 57400
Mathematical Modeling of Physical Systems I	MATH 57800
Introduction to Logic for Teachers	MATH 58100
History of Elementary Mathematics	MATH 58300
Mathematical Logic I	MATH 58500
General Set Theory	MATH 58700
Mathematical Modeling of Physical Systems II	MATH 58800
Topics in Mathematics	MATH 59800
Methods of Applied Mathematics I	MATH 61100
Methods of Applied Mathematics II	MATH 61200
Mathematical Formulation of Physical Problems I	MATH 62600
Mathematical Formulation of Physical Problems II	MATH 62700
Functional Analysis	MATH 64600
Dynamical Systems II	MATH 66700
Algebraic Topology I	MATH 67200
Algebraic Topology II	MATH 67300
Mathematical Physics II	MATH 67400
Topics in Applied Mathematics	MATH 69200
Topics in Analysis	MATH 69300
Topics in Differential Equations	MATH 69400
Topics in Topology	MATH 69700
Research Ph.D. Thesis	MATH 69900
Statistical Methods I	STAT 51100
*Applied Regression Analysis	STAT 51200
Statistical Quality Control	STAT 51300
*Design of Experiments	STAT 51400
Statistical Consulting Problems 1-3	STAT 51500
*Basic Probability and Applications	STAT 51600
*Statistical Inference	STAT 51700
Introduction to Probability	STAT 51900

*Probability Theory	STAT 51900 (MATH 51900)
Time Series and Applications	STAT 52000
Statistical Computing	STAT 52100
Sampling and Survey Techniques	STAT 52200
Categorical Data Analysis	STAT 52300
*Applied Multivariate Analysis	STAT 52400
Generalized Linear Models	STAT 52501
*Mathematical Statistics	STAT 52800
Applied Decision Theory and Bayesian Analysis	STAT 52900
Elements of Stochastic Processes	STAT 53200 (MATH 53200)
Nonparametric Statistics	STAT 53300
Introduction to Survival Analysis	STAT 53600
Probability Theory	STAT 61900
Research M.S. Thesis	STAT 69800

***Denotes Core Courses for Pure and Applied Mathematics, Statistics and Math Education tracks.**

Appendix B: Faculty: Areas of Specialization

Julia Arciero, PhD, Assistant Professor; Applied Mathematics, Mathematical Biology

P Bleher, PhD, Chancellor Professor; Mathematical Physics, Statistical Physics, Probability Theory, Random Matrix Models, Quantum Mechanics and Quantum Chaos, Random Polynomials, Renormalization Group, Critical Phenomena and Phase Transitions, Lattice Point Problems, Semiclassical Asymptotics

Benzion Boukai, PhD, Professor; Mathematical Statistics and Applications

Olguta Buse, PhD, Associate Professor; Symplectic and Contact Geometry, Topology

Clyde D Counts, MA, Lecturer; Mathematics

Carl Cowen, PhD, Professor; Operator Theory, Complex Analysis, Linear Algebra

Christopher Dona, MS, Lecturer; Finite Mathematics, Probability Theory, Mathematics Education

G Duane Farris, MS, Lecturer; Mathematics

Patrick Frey, MS, Lecturer; Mathematics

William Geller, PhD, Associate Professor; Dynamical Systems, Game Theory

Giovanna Guidoboni, PhD, Associate Professor; Applied Mathematics, Continuum Mechanics, Mathematical Biology

Henry Hernandez, MS, Lecturer; Mathematics

Clay Hicks, MS, Lecturer; Mathematics

Alexander Its, PhD, Distinguished Professor; Mathematical Physics

Elizabeth Its, PhD, Research Associate Professor; Applied Mathematics

Ronghui Ji, PhD, Associate Professor; Mathematics

Bruce Kitchens, PhD, Associate Professor; Dynamical Systems and Ergodic Theory

Nancy Kitt, MA, Lecturer; Mathematics Education, Developmental Mathematics Courses

Slawomir Klimek, PhD, Associate Professor; Mathematical Physics, Noncommutative Geometry, Number Theory

Alexey Kuznetsov, PhD, Associate Professor; Applied Mathematics

Fang Li, PhD, Associate Professor; Statistics

Judy McBride, MS, Senior Lecturer; Mathematics Education

Bryan Melsheimer, MS, Full-Time Lecturer; Pre-Calculus

Susan Meshulam, MS, Senior Lecturer; Mathematics

John L Miller, PhD, Lecturer; Mathematics

Michal Misiurewicz, PhD, Professor; Dynamical Systems, Ergodic Theory

Yaroslav Molkov, PhD, Assistant Professor; Applied Mathematics

R Patrick Morton, PhD, Professor; Number Theory, Algebra, Geometry

Evgeny Mukhin, PhD, Professor; Mathematics, Mathematical Physics

Hanxiang Peng, PhD, Associate Professor; Statistics

Rodrigo Perez, PhD, Associate Professor; Dynamical Systems; in particular 1- and 2-dimensional Complex Dynamics, Geometric Group Theory, Combinatorics

Joan Rainey, MA, Lecturer; Mathematics

Daniel Ramras, PhD, Assistant Professor; Mathematics

Sharon Rangazas, MA, Senior Lecturer; Mathematics

Mamunur Rashid, PhD, Lecturer; Statistics, Logistic Regression, Statistical Inference

Roland Roeder, PhD, Assistant Professor; Dynamical Systems, Complex Analysis, Hyperbolic Geometry

Leonid Rubchinsky, PhD, Associate Professor; Mathematical Biology, Computational Neuroscience, Dynamical Systems

Jyotirmoy Sarkar, PhD, Professor; Statistics, Probability, Economics

Asok K Sen, PhD, Professor; Mathematics

Zhongmin Shen, PhD, Professor; Mathematics

Richard Tam, PhD, Associate Professor; Applied Mathematics, Combustion Theory

Fei Tan, PhD, Assistant Professor; Biostatistics, Statistics, Public Health

Vitaly Tarasov, PhD, Professor; Statistics, Probability, Economics

Jeffrey Xavier Watt, PhD, Associate Professor; Mathematics Education

Maxim Yattselev, PhD, Assistant Professor; Mathematics

Wei Zheng, PhD, Assistant Professor; Statistics, Design of Experiments

Luoding Zhu, PhD, Associate Professor; Blood Flows, Numerical Methods, Scientific Computing

Appendix C: History and size of the IUPUI Mathematical Sciences Ph.D. degree program.

The first student, completed Ph.D. thesis under the direction of a Mathematical Sciences faculty member in Indianapolis in 1986 (Ellen Maycock Parker), she finished her course work on the West Lafayette campus.

The first Ph.D. student graduated from the Department in 1993 (Vic Perera), who received his full training, including all course work, in Indianapolis.

In the next years, the Department produced Ph.D. graduates as shown in the table:

1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	1	0	2	0	1	0	1	1	2
2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	0	2	0	1	1	4	1	0	3

In year 2013, there were five Ph.D. graduates.

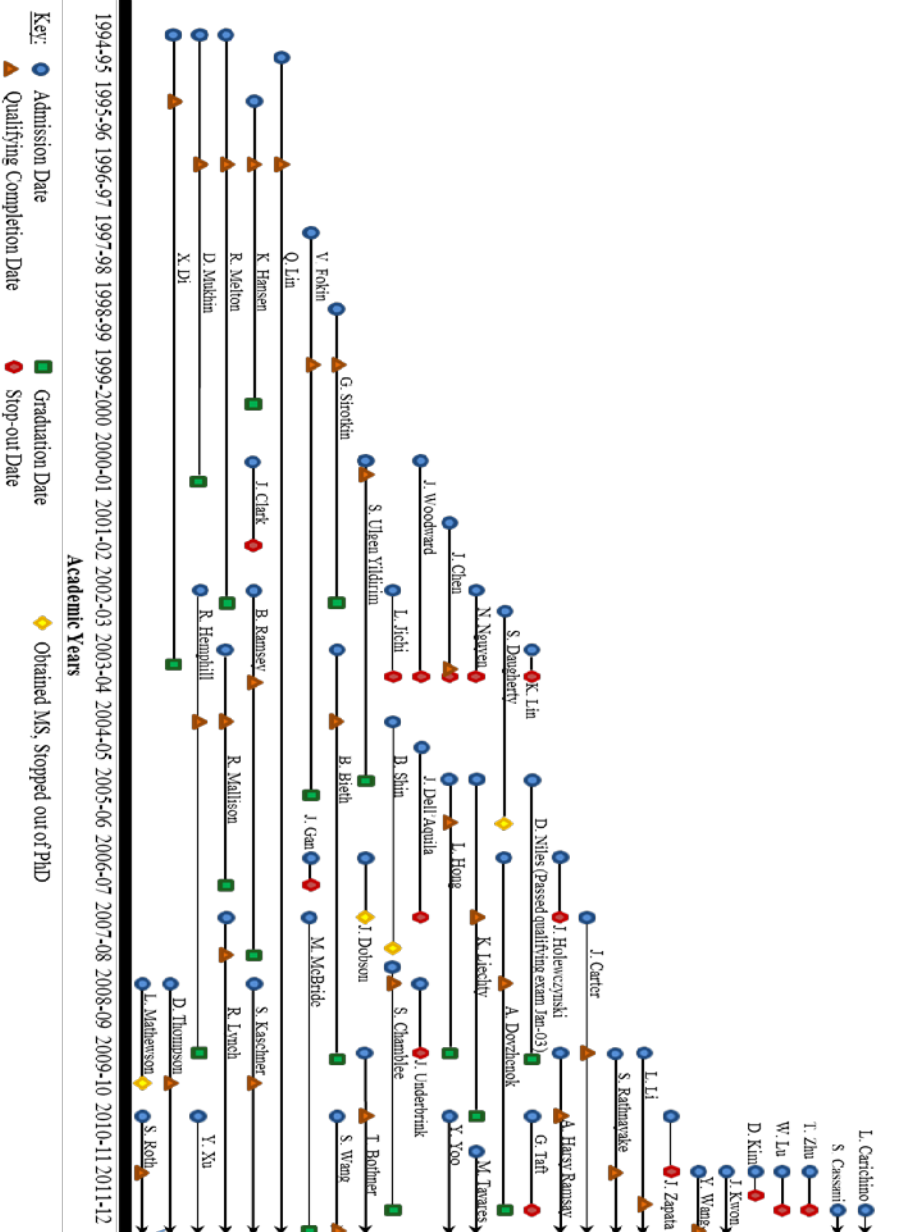
That makes a total of 27 Ph.D. Mathematics graduates from the Department of Mathematical Sciences at IUPUI up to this point. Each received a Purdue University Ph.D. in Mathematics awarded at West Lafayette.

The current plan is to graduate five to seven students per year on regular basis. In fall 2015, there will be 40 Ph.D. students, 36 of whom will receive financial support from the Department (both TA and Fellowships). Among them, eight are domestic students, 10 are female students.

The students are able to choose emphasis areas in Pure Mathematics, Applied Mathematics or Mathematical Statistics

- Pure Mathematics area has 19 students, nine of them completed the qualifying exams.
- Applied Mathematics area has eight students, six passed the qualifying exams. This area is being actively developed with the recent hiring of several new faculty. In particular, we started the qualifying exam in Numerical Analysis and are working on adding several graduate courses in applied mathematics.
- Mathematical Statistics has nine students, four passed the qualifying exams. This is a new area which was approved by Purdue only in 2009, and first two students are expected to graduate in May 2015. The students in this area are required to take two core mathematical exams (typically, Real Analysis and Linear Algebra) and two subject exams: Probability and Mathematical Statistics. The other requirements to complete the program are the same as for Ph.D. students with concentrations in pure and applied mathematics.

The next chart shows progress in the program of each matriculated student up to year 2012.



Data on Ph.D. Graduates

Below is a list of Ph.D. graduates since 2006 along with their dissertation topic, faculty advisor, and career information. Our faculty play a major role in supporting our students to help them reach their academic and career goals.

A. Harsy

2014; Locally compact property A groups; Advisor: R. Ji; First Position: Assistant Professor, Lewis University, Romeoville, IL

Q. Lin

2013; A jackknife empirical likelihood approach to goodness of fit u-statistic testing with side information; Advisor: H. Peng; First Position: Consultant Statistician, Eli Lilly and Company, Indianapolis, IN

T. Bothner

2013; Asymptotics of the Fredholm determinant corresponding to the first bulk critical universality class in random matrix models; Advisor: A. Its; First Position: CRM-ISM Postdoctoral Fellow, Centre de Recherches Mathematiques (CRM), Universite de Montreal, Montreal, Quebec, Canada

J. Carter

2013; Commutants of composition operators on the Hardy space of the disk; Advisor: C. Cowen; First Position: Knowledge Engineer, Ke Labs, Inc., Carmel, IN

S. Kaschner

2013; Superstable manifolds of invariant circles and codimension-1 Bottcher functions; Advisor: R. Roeder; First Position: Teaching Postdoc, University of Arizona, Tucson, AZ

D. Thompson

2013; Restrictions to invariant subspaces of composition operators on the Hardy space of the disk; Advisor: C. Cowen; First position: Assistant Professor, Trine University, Angola, IN; Current position: Assistant Professor of Mathematics, Taylor University, Upland, IN

S. Chamblee

2012; Dynamics of twisted tent maps; Advisor: M. Misiurewicz; First position: Junior Actuary, Indiana Department of Insurance, Indianapolis, IN

A. Dovzhenok

2012; Mathematical models of basal ganglia dynamics; Advisor: L. Rubchinsky; First position: Postdoctoral Fellow, University of Cincinnati, Cincinnati, OH

M. McBride

2012; D-bar and Dirac operators on classical and quantum domains; Advisor: S. Klimek; First position: Visiting Assistant Professor of Mathematics, University of Oklahoma, Norman, OK

K. Liechty

2010; Exact solutions to the six-vertex model with domain wall boundary conditions and uniform asymptotics of discrete orthogonal polynomials on an infinite lattice; Advisor: P. Bleher; First position: Postdoctoral Assistant Professor, University of Michigan, Ann Arbor, MI; Current position: Assistant Professor, DePaul University, Chicago, IL

B. Bieth

2009; Developing fast and accurate parallel solver for multi-scales biochemical reacting systems; Advisor: R. Chin; First position: Modeler, Novartis Pharma AG, Basel, Switzerland

R. Hemphill

2009; Robust equilibria: normal-form, extensive-form, and repeated games; Advisor: W. Geller; First position: Actuarial Consultant, Timmerberg and Associates, Indianapolis, IN; Current position: Senior Actuary, California Department of Insurance, Los Angeles, CA

L. Hong

2009; Limiting performance of a one-unit system under various repair models; Advisor: J. Sarkar; First position: Assistant Professor of Mathematics and Actuarial Science, Bradley University, Peoria, IL; Current position: Assistant Professor of Mathematics & Actuarial Science, Robert Morris University, Pittsburgh, PA

D. Niles

2009; Riemann-Hilbert-Birkhoff inverse monodromy problem and connection formulae for the third Painleve transcendents; Advisor: A. Its; First position: Postdoctoral Fellow, IUPUI, IN

B. Ramsey

2008; A generalization of the Lyndon-Hochschild-Serre spectral sequence for polynomial cohomology.; Advisor: R. Ji; First position: Postdoctoral Fellow, IUPUI, IN; Current position: Ross Assistant Professor, The Ohio State University, Columbus, OH

B. Mallison

2007; Zeros of sections of exponential sums; Advisor: P. Bleher; First position: Assistant Professor, Indiana Wesleyan University, IN; Current position: Associate Professor, Indiana Wesleyan University, IN



DEPARTMENT OF
MATHEMATICS

INDIANA UNIVERSITY
College of Arts and Sciences
Bloomington

May 20, 2015

The Graduate School
Purdue University
West Lafayette, IN 47907

To whom it may concern:

I am writing to support the proposal of the Department of Mathematical Sciences at Indiana University-Purdue University at Indianapolis (IUPUI) to have independent administration of its PhD. I understand that this degree would be a University of Purdue PhD degree awarded at IUPUI.

The Department of Mathematical Sciences at IUPUI is a diverse and active department whose faculty members produce quality research in pure mathematics, applied mathematics, statistics and biostatistics, and mathematics education. The faculty includes many scholars with both national and international reputations. Besides pure mathematicians working in areas such as dynamical systems, mathematical physics, and blends of algebra with topology, the Department has applied mathematicians and statisticians working on health data sciences and biomathematics modeling. Much of this work is in collaboration with faculty members at Indiana University and Purdue University.

I understand that the PhD program in the Department of Mathematical Sciences at IUPUI has functioned for over 20 years through Memorandums of Understanding (MOU) between the Department of Mathematical Sciences at IUPUI and the Department of Mathematics at Purdue University. The program at IUPUI has been a very successful program, producing many graduates who have gone on to worthwhile professional careers in academics, public service, and the private sector.

It is in the best interests of the State of Indiana to grant the request from the Department of Mathematical Sciences at IUPUI for independent control of its PhD program. With its location in Indianapolis and proximity to the Medical School, the Department of Mathematical Sciences at IUPUI plays a unique role in mathematics education and training in the State of Indiana, creating a highly trained and knowledgeable scientific workforce that bolsters Indiana's competitiveness. Autonomy of the PhD program will enhance the department's ability to meet the ever changing needs of its own, unique community of scholars.

Sincerely,

Elizabeth Housworth, Chair

August 28, 2015

The Department of Mathematical Sciences of Indiana University-Purdue University at Indianapolis (IUPUI) seeks to have independent administration of its PhD program and hence to have the authority to confer a Purdue University PhD degree awarded at IUPUI. We write to support this proposal.

The Department of Mathematical Sciences at IUPUI is a diverse and active department whose faculty members produce quality research in pure mathematics, applied mathematics, statistics and biostatistics, and mathematics education. The faculty includes many scholars with both national and international reputations for the depth and breadth of their research. Besides pure mathematicians working in areas such as dynamical systems, mathematical physics, and blends of algebra with topology, the Department has applied mathematicians and statisticians working on health data sciences and biomathematics modeling. Much of this work is in collaboration with faculty members at Indiana University and Purdue University.

The PhD program in the Department of Mathematical Sciences at IUPUI has functioned for over 20 years through Memoranda of Understanding (MOU) between the Department of Mathematical Sciences at IUPUI and the Department of Mathematics at Purdue University. This has been a very successful program, producing many graduates who have gone on to worthwhile professional careers in academics, public service, and the private sector.

Based on our experience and the approval of the Graduate Committee of the Purdue University Department of Mathematics, we believe it is in the best interests of the State of Indiana to grant the request from the Department of Mathematical Sciences at IUPUI to have fully independent control of its PhD program. The demand for well-trained professionals at the PhD level in the STEM disciplines has never been higher. Granting this request will help Indiana meet this demand and continue, in this way, to address the challenges our state faces in creating a highly trained and knowledgeable scientific workforce.

Sincerely,



Gregory T. Buzzard
Professor and Head



David Goldberg
Professor and Associate Head for Graduate Studies

John C. Lechleiter, Ph.D.

Chairman, President, and Chief Executive Officer

317.276.6997 | jcl@lilly.com



Eli Lilly and Company

Lilly Corporate Center
Indianapolis, Indiana 46285
U.S.A.

www.lilly.com

May 11, 2015

Simon J. Rhodes, Ph.D.
Dean, School of Science
IUPUI
402 North Blackford Street, LD 222
Indianapolis, IN 46202

Dear Dr. Rhodes,

I am pleased to offer my support for your proposals for independent Ph.D. degrees in the School of Science at IUPUI. My colleagues at Lilly and I have been pleased to witness the emergence of the School of Science as an excellent research and learning institution and key asset in our shared ambition to make Indiana a hub of discovery and innovation. IUPUI graduates of the current Ph.D. programs awarded through the West Lafayette campus hold important positions in both our research laboratories and in other areas of our company. We have benefitted from the outstanding training they received. Clearly, you are ready to operate your own Ph.D. programs.

We have been particularly pleased with the benefits to our employees who have taken advantage of the opportunity to enhance their qualifications and contributions to our discovery mission by studying for the Ph.D. through the LGRAD program that we developed together. They are well prepared to assume higher levels of responsibility in their research groups. Moreover, this training is beneficial to the company as we seek to develop our own scientists as leaders in their fields of inquiry and to retain the best and brightest.

We also realize that your undergraduate degree students (the vast majority of whom are from Indiana) enjoy opportunities to have significant engagements in research. These research experiences help develop important skills that Indiana employers seek in new hires. Enriching the research environment by solidifying the Ph.D. degree programs will further improve the education and preparation of your undergraduates.

I believe that approval of the independent status you are requesting will strengthen your programs even further by allowing them to participate in national rankings and by making them fully eligible for external funding programs that are restricted to those with independent doctoral degrees. All of us in Indiana's life sciences community, and other contributors to our economy and quality of life, will share the benefits.

Sincerely,

Appendix E: Headcounts and Cost Projections

Indiana University-Purdue University Indianapolis
Ph. D. in Mathematical Sciences

	Headcount Enrollment					Total Credit Hours/head					Total Credit Hours					FTE				
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 1	Year 2	Year 3	Year 4	Year 5	Year 1	Year 2	Year 3	Year 4	Year 5	Year 1	Year 2	Year 3	Year 4	Year 5
New HC																				
Res																				
FT	1	1	1	1	1	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
	2		1	1	1	18	18	18	18	18	-	18	18	18	18					
	3			1	1	18	18	18	18	18	-	-	18	18	18					
	4				1	18	18	18	18	18	-	-	-	18	18					
	5				1	18	18	18	18	18	-	-	-	-	18					
PT																				
	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nres																				
FT	1	2	2	2	2	18	18	18	18	18	36	36	36	36	36					
	2		2	2	2	18	18	18	18	18	-	36	36	36	36					
	3			2	2	18	18	18	18	18	-	-	36	36	36					
	4				2	18	18	18	18	18	-	-	-	36	36					
	5				2	18	18	18	18	18	-	-	-	-	36					
PT																				
	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trfr HC																				
Res																				
FT	1	2	2	2	2	18	18	18	18	18	36	36	36	36	36					
	2		2	2	2	18	18	18	18	18	-	36	36	36	36					
	3			2	2	18	18	18	18	18	-	-	36	36	36					
	4				2	18	18	18	18	18	-	-	-	36	36					
	5				2	18	18	18	18	18	-	-	-	-	36					
PT																				
	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nres																				
FT	1	6	6	6	6	18	18	18	18	18	108	108	108	108	108					
	2		6	6	6	18	18	18	18	18	-	108	108	108	108					
	3			6	6	18	18	18	18	18	-	-	108	108	108					
	4				6	18	18	18	18	18	-	-	-	108	108					
	5				6	18	18	18	18	18	-	-	-	-	108					
PT																				
	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
																or hr per FTE: 24				
Total	11	22	33	44	55						198	396	594	792	990	8.25	16.50	24.75	33.00	41.25
Res	3	6	9	12	15						54	108	162	216	270	2.25	4.50	6.75	9.00	11.25
Nres	8	16	24	32	40						144	288	432	576	720	6.00	12.00	18.00	24.00	30.00
FT	11	22	33	44	55						198	396	594	792	990	8.25	16.50	24.75	33.00	41.25
PT	-	-	-	-	-						-	-	-	-	-	0.00	0.00	0.00	0.00	0.00
New	3	6	9	12	15						54	108	162	216	270	2.25	4.50	6.75	9.00	11.25
Res	1	2	3	4	5						18	36	54	72	90	0.75	1.50	2.25	3.00	3.75
Nres	2	4	6	8	10						36	72	108	144	180	1.50	3.00	4.50	6.00	7.50
Trnfr	8	16	24	32	40						144	288	432	576	720	6.00	12.00	18.00	24.00	30.00
Res	2	4	6	8	10						36	72	108	144	180	1.50	3.00	4.50	6.00	7.50
Nres	6	12	18	24	30						108	216	324	432	540	4.50	9.00	13.50	18.00	22.50
GRADS																				
if 4-yr	-	-	-	-	11															

NEW ACADEMIC DEGREE PROGRAM PROPOSAL SUMMARY

Institution/Location: Indiana University-Purdue University Indianapolis
 Program: Ph. D. in Mathematical Sciences
 Proposed CIP Code: 27.0101
 Base Budget Year: 2014-15

	Year 1 2016-17	Year 2 2017-18	Year 3 2018-19	Year 4 2019-20	Year 5 2020-21
Enrollment Projections (Headcount)					
PhD Program	11	22	33	44	55
Master of Arts Program	-	-	-	-	-
	11	22	33	44	55
Enrollment Projections (FTE)					
PhD Program	8	17	25	33	41
Master of Arts Program	-	-	-	-	-
	8	17	25	33	41
Degree Completion Projection	-	-	-	-	11

CHE Code:
 Campus Code:
 County Code:
 Degree Level:
 CIP Code:

Table 1
Question 3a: Cost of and Support for the Program
Detail on Direct Program Costs
Indiana University-Purdue University Indianapolis
Ph. D. in Mathematical Sciences

Ph. D. in Mathematical Sciences										
27.0101	Year 1		Year 2		Year 3		Year 4		Year 5	
	FTE	2016-17	FTE	2017-18	FTE	2018-19	FTE	2019-20	FTE	2020-21
Personnel Services										
Faculty	0.8	\$ 72,000	1.6	\$ 144,000	2.3	\$ 207,000	3.2	\$ 288,000	4.0	\$ 360,000
Staff	-	-	-	-	-	-	-	-	-	-
Graduate Assistants	1.5	69,000	3.0	138,000	4.5	207,000	6.0	276,000	7.5	345,000
Total Personnel Services		\$ 141,000		\$ 282,000		\$ 414,000		\$ 564,000		\$ 705,000
Supplies and Expense										
General Supplies and Expense		\$ 64,800		\$ 129,600		\$ 183,600		\$ 248,400		\$ 313,200
Recruiting		-		-		-		-		-
Travel		-		-		-		-		-
Library		-		-		-		-		-
Total Supplies and Expense		\$ 64,800		\$ 129,600		\$ 183,600		\$ 248,400		\$ 313,200
Equipment										
New Equipment (see narrative)		\$ -		\$ -		\$ -		\$ -		\$ -
Equipment Replacement		-		-		-		-		-
Total Equipment		\$ -		\$ -		\$ -		\$ -		\$ -
Facilities (see narrative)		\$ -		\$ -		\$ -		\$ -		\$ -
Student Assistance										
Graduate Fee Scholarships		\$ 39,600		\$ 79,200		\$ 118,800		\$ 158,400		\$ 198,000
Fellowships		-		-		-		-		-
Total Student Assistance		\$ 39,600		\$ 79,200		\$ 118,800		\$ 158,400		\$ 198,000
Total Costs		\$ 245,400		\$ 490,800		\$ 716,400		\$ 970,800		\$ 1,216,200