

INSTITUTION: (Purdue University)

CAMPUS: Indiana University Purdue University Indianapolis (IUPUI)

COLLEGE: School of Engineering & Technology

DEPARTMENT/SCHOOL: Department of Electrical & Computer Engineering

DEGREE PROGRAM TITLE: Ph.D. in Electrical & Computer Engineering

SUGGESTED CIP CODE:

PROJECTED DATE January 1, 2018

SIGNATURE PAGE

Degree Title Ph.D. in Electrical & Computer Engineering

Name of academic unit offering the new degree

Department of Electrical & Computer Engineering in the School of Engineering & Technology at Indiana University Purdue University Indianapolis (IUPUI)

Signature of Department Head
(Name of Department)

Date

Signature of Academic Dean
(Name of College/School)

Date

Director of Graduate Studies
(for regional campuses)

Date

PURDUE BOARD OF TRUSTEES

**TEMPLATE FOR
1-PAGE EXECUTIVE SUMMARY**

INTRA-AGENCY ADVISORY AND DELIBERATIVE MATERIAL

MEMORANDUM

Executive Summary of Upcoming Board Review or Action Item

DATE: August 15, 2016

TO: Board of Trustees

FROM: Brian King, Primary Contact, (317) 274-9723 ; briking@iupui.edu

SUBJECT: Submission of Proposal for a Ph.D. in Electrical & Computer Engineering at the Indiana University Purdue University Indianapolis campus

Purpose:

- This item is recommended for discussion by the Board in executive session.
- This item is recommended for discussion by the Committee at its meeting.
- X** **This item will require a formal vote by the Academic Affairs Committee at its meeting.**
- This item will require a formal vote by the Board in the Stated Meeting.
- This item will be presented in a formal resolution for action at the Stated Meeting.

Attachments: *[List any attachments to the memo as Exhibits or Appendices or note, "No Attachments"]* **Appendix A Supplementary Preproposal documentation**

Executive Summary (1-page) included: *[Provides a high level narrative and should provide some interpretative commentary surrounding any data or other graphical information being provided in any attachments.]*

EXECUTIVE SUMMARY

Ph.D. in Electrical & Computer Engineering
Purdue School of Engineering & Technology
Indiana University-Purdue University Indianapolis,
Indianapolis, IN

The Purdue School of Engineering & Technology at Indiana University-Purdue University Indianapolis (IUPUI) seeks to transition its current cooperative agreement for participation in the Ph.D. Program of Purdue University for Studies in the School of Electrical and Computer Engineering to an IUPUI site-approved ECE Ph.D. degree program. The cooperative agreement entitled: “*A Cooperative Agreement Between: The Purdue School of Engineering and Technology, IUPUI and The School of Electrical and Computer Engineering, Purdue University, West Lafayette,*” was approved in September 2003. The ECE Department at IUPUI has been successful and active in providing Ph.D. training in Indianapolis for nearly 12 years and has advanced to the stage in which a site-approved program is a logical and necessary transition for further student and faculty success, while contributing to the economic workforce needs of the State of Indiana.

Given the experience and maturity of the IUPUI ECE Department and the success of its students, the terms and conditions of the existing cooperative agreement place unnecessary limitations on the students and the faculty that it is intended to serve. Under the current agreement IUPUI doctoral students are required to take at least half of their courses and all dissertation credits on the West Lafayette campus. All degrees are awarded by the West Lafayette campus even though the research is conducted on the IUPUI campus and supported by grants and awards to the faculty and students in Indianapolis. The proposed site autonomy for the Ph.D. program in Electrical & Computer Engineering at IUPUI will facilitate an enhanced venue for delivery of engineering research and training that will be unique and provide much needed support to the central Indiana community. Further, niche areas, such as the Transportation Active Safety Institute, will soon advance to be an internationally recognized institute, such a research institute needs a site approved Ph.D. offering, in order to provide the necessary graduate student research assistants. Also, collaborations between ECE at IUPUI and West Lafayette will be strengthened based on complimentary faculty and students research interests and objectives, rather than mandated by Ph.D. student committee composition requirements as specified under the current agreement. Collaborations based on complimentary research interests/objectives can provide greater overall benefits to both campuses, such as increased access to local industry partners with an IUPUI collaborator available to reach out to the local industrial partner in a timely manner; or as an enabling bridge between faculty in West Lafayette and the expanding health/medical industry and facilities in Indianapolis. Currently, there are no other Ph.D. engineering programs in Electrical and Computer Engineering in the metropolitan Indianapolis area and none in the region with the leading research foci being pursued by the department. It is also clear that local Ph.D. training opportunities in Electrical and Computer Engineering are desired by regional employers, such as Interactive Intelligence, Raytheon, Cummins, Delphi, LHP, Rolls Royce, and NSW Crane, as well as other employers both nationally and internationally in the research areas being pursued by the department including Toyota, Delphi, Ford, BMW, and Samsung among others.

Finally, a site-approved Ph.D. in ECE will also serve the goals of IUPUI by increasing the graduate research and training efforts in an area that aligns with the health science-oriented commitment of the IUPUI campus. For example, there is a strong collaboration between ECE at IUPUI and the IU School of Medicine in the area of automobile driver studies and active safety systems, including the analysis of the impact of alcohol on driver performance. The ECE Department has a strong research program that is capable of supporting the proposed Ph.D. program.

The ECE Department currently has 17 tenured/tenure-track faculty members who are committed to high quality research and teaching, with research emphasis in areas that include transportation active safety, automatic control, medical image processing, signal processing, power, renewable energy, data analytics, information intelligence, cybersecurity, and sensor technologies. Faculty research efforts have been well funded by various agencies including NSF (including NSF CAREER awards), NIH, and the Department of Defense.

PROPOSAL
Ph.D. in Electrical & Computer Engineering
Purdue School of Engineering & Technology
Indiana University-Purdue University Indianapolis,
Indianapolis, IN

Characteristics of the Program

- a) **Campus(es) Offering Program:** Indiana University-Purdue University Indianapolis (IUPUI)
- b) **Scope of Delivery Specific Sites or Statewide:** IUPUI
- c) **Mode of Delivery:** Classroom
- d) **Other Delivery Aspects:** Ph.D. students will be required to participate in research and have the option to complete internships related to their plan of study.
- e) **Academic Unit Offering Program:** School of Engineering & Technology, IUPUI
- f) **Department:** Electrical and Computer Engineering

Rationale for Program

a) Institutional Rationale (e.g. Alignment with Institutional Mission and Strengths)

IUPUI is an urban, core research campus of Indiana University and often characterized as the State of Indiana's "Health & Life Sciences" campus. There has been tremendous increase in the number of academic programs at IUPUI. In particular, there has been significant growth in Ph.D. programs, which reflects IUPUI's evolution as a research university. The Purdue School of Engineering & Technology seeks to transition from a cooperative agreement of participation in the Purdue West Lafayette ECE Ph.D. program to a site-approved doctoral degree program in Electrical & Computer Engineering at IUPUI. This transition reflects the vision for research development in the department with its ability to deliver quality specialized research as well as to mentor graduate students in these areas. Some of the niche research areas of focus in the department include transportation active safety systems, automatic control power, renewable energy, signal processing, cybersecurity, medical imaging, data analytics, information intelligence, and sensor technologies, especially in the context of health sciences.

The proposed program will build upon the existing research strengths of the ECE Department and will leverage the resources available in Indianapolis and on the IUPUI campus in order to train the next generation of Electrical and Computer Engineers and enable them to actively participate in meeting industry demands, primarily, in Central Indiana but also in Indiana, the greater Midwest and the nation. The IUPUI campus vision is "to be the best urban research university by conducting world-class research, scholarship, and creative activities that develop knowledge and contribute to the economic growth and social advancement of Indiana and the nation and benefit humanity as a whole." Engineering is essential to IUPUI achieving this vision and a site-approved ECE Ph.D. program provides a unique opportunity for the department to become an active participant in this vision. Missing this opportunity will certainly translate into the organic redistribution of advanced engineering research activities across several schools. The above-mentioned factors, together with the evolution of the IUPUI campus and changes in the local economy, makes an Indianapolis-based ECE doctoral program not just an aspiration but also a pressing need in order to sustain the active participation of our department in the research and educational enterprise of Central Indiana, the home of many engineering, information technology, life and health sciences, and manufacturing industries.

The ECE Department has been offering a site-approved MSECE degree for many years. Under the current agreement with the ECE department at Purdue University West Lafayette (PUWL), we have Ph.D. students who are members of the ECE PUWL Ph.D. program. These students have a permanent home on

the IUPUI campus. They conduct research at IUPUI and take courses both at IUPUI and PUWL. However, the current agreement requires that the majority of their courses be taken at PUWL. In addition, admissions for the program are processed by PUWL. Despite these constraints, our PhD student population has maintained a level of more than 12 Ph.D. students over the past five years. This relative success can primarily be attributed to the significant subsidy of the program by the School of Engineering and Technology at IUPUI as well as the determination of the faculty members to making the program a success. Nonetheless, the lack of self-sustainability of the program has hindered its growth. Indeed, the current restrictions make it difficult for the department to grow the Ph.D. program and definitely make the program less attractive to potential Ph.D. students for whom pursuing a Ph.D. program in Indianapolis is the only possible option.

Faculty members of the ECE Department have been successfully training Ph.D. students for several years. Even prior to the adoption of the cooperative agreement between ECE and ECE PUWL, numerous faculty members were mentoring Ph.D. students at other universities. We have qualified faculty and nearly all have experience with Ph.D. mentoring and training. Furthermore, the ECE department has been the recipient of many substantial and competitive research awards. For instance, two of our faculty members are the recipient of the NSF Career Award and several have patents. Doctoral students in the ECE program at IUPUI also benefit from our campus membership in the NSF-sponsored consortium CIRT, Center for Integration of Research, Teaching and Learning, which provides career development programs specifically for STEM-focused graduate students. In order, for the ECE department to continue to be increasingly competitive in

- the delivery of high quality research,
- the recruitment and retention of top research faculty talent, and
- in the provision of an environment conducive to faculty success,

a high quality onsite Ph.D. program that can further stimulate the research activities on campus is an absolute necessity.

b) State Rationale

Our graduate program is aligned with delivering a well-trained STEM workforce to address the needs of the State of Indiana. The growth of our master's program has been realized by a large increase in students seeking engineering degrees in response to the employment needs of STEM related industries. Today, a substantial percentage of our BSEE, BSCmpE and MSECE graduates are contributing to central Indiana's economy and industries. Indeed these alumni have been recruited in local companies such as Interactive Intelligence, Raytheon, Cummins, LHP, Rolls Royce, NSW Crane and others.

An ECE Ph.D. program in the most populous city of Indiana would be in-line with the state's vision and mission for STEM education (<https://www.istemnetwork.org/about-us/vision-mission-and-goals/>). Furthermore, a site-autonomous ECE Ph.D. will also support research activities in the fields of health and life sciences and transportation/automotive in Central Indiana. Other areas that an ECE Ph.D. degree program will impact include automatic control, power, renewable energy, electronics, cybersecurity, medical imaging, data analytics, and sensor technologies.

Moreover, a site-autonomous ECE Ph.D. program will reduce administrative and logistics barriers for ECE PhD students. For instance, under the current agreement, ECE PhD applicants from IUPUI need to complete 3 admission applications: one to PUWL, a second to IUPUI and a third to PUWL as a non-degree student. The latter application allows them to take the required classes at PUWL.

c) Evidence of Labor Market Need

i) National, State, or Regional Need

The enrollment in the department's M.S. program has doubled in the last five years, primarily due to growth in full-time students. This growing number of M.S. students have been recruited by central Indiana industries. We believe that a large percentage of these master degree graduates, either in Central Indiana or with ties to Central Indiana, would consider pursuing a Ph.D. program if the program was available onsite. Furthermore, we believe that a PhD program in an urban area will a) allow greater face-to-face-interaction between PhD students and industry, b) promote growth in co-op opportunities for students and c) provide a pool of resources for industries experiencing shortage in their highly technical workforce. Finally, an urban PhD program is a flexible venue and will inspire surrounding industries to encourage their current employees to pursue a doctoral degree as a means for professional development without the hardship of extended leaves.

ii) Preparation for Graduate Programs or Other Benefits

A Ph.D. in Electrical & Computer Engineering is a terminal degree.

iii) Summary of Indiana Department of Workforce Development and/or U.S. Department of Labor Data

The US Department of Labor indicates that job outlook in hardware computer engineering and electrical engineering will achieve slight and little growth from 2014 to 2024, respectively. These are national trends that may not be locally relevant. Furthermore, the report focus is on undergraduate students which may not be related to potential growth for graduate students with advanced technical skills. A counter example can be observed in the two-fold increase of our own M.S. degree enrollment over the past five years.

iv. National, State, or Regional Studies

In the *NACE Job Outlook Survey for 2016* (National Association of Colleges and Employers)¹, in their job outlook for doctoral degrees, the top five doctoral degrees for which employers expressed their greatest need are in order: i)Electrical Engineering, ii) Computer Science, iii)Software Engineering, iv) Computer Engineering and iv) Mechanical Engineering (with the last two tied).

3) Quality and Other Aspects of the Program

a) Credit Hours Required/Time to Completion

The proposed Ph.D. program requires 90 credit hours for completion. The program is modeled after the ECE Ph.D. program at Purdue West Lafayette, with few modifications that emphasize local strengths and capabilities.

The requirements described in this proposal reflect requirements for both students who have applied and were admitted to the PhD program after having completed a Master's degree and to those students admitted directly after their undergraduate program (called Direct Admits). At any time when requirements for PhD students with Masters degrees differs with requirements for PhD students who are Direct Admits, then the difference will be indicated clearly.

¹ <http://www.naceweb.org/>

The ECE Ph.D. program at IUPUI will primarily focus on five areas. These areas are a subset of the areas offered in the ECE Ph.D. program at Purdue West Lafayette and consist of:

- Automatic Control
- Power and energy
- Communications/Signal Processing
- Computer Engineering
- VLSI and Circuit Design

Students will choose a **primary area** from the above list. A minimum of 39 graduate course credit hours (non-thesis credit hours) are needed to fulfill the course requirements of the program. These courses must include

- PhD students who are Direct Admits must complete at least 2 ECE core courses, one of which in the primary area (see Table 1), These requirements can only be satisfied by completing the courses at IUPUI or PUWL
- PhD Students admitted to the PhD program with a Masters degree must complete the core course in their primary area (or an equivalent course)
- 2 ECE courses numbered 61100 or higher, and
- at least 18 graduate credit hours from the student’s primary area.
- 2 graduate mathematics courses and 3 related area courses; or 3 graduate mathematics courses and 2 related area courses
- ECE 69401 seminar course
- The remaining credit hours will be satisfied by completing credit hours in ECE 69900.
- A PhD student will be required to take at least 1 research credit ECE 69900 each semester (excluding summer).

The above requirements are summarized in Table 2 below. In addition to these requirements, ECE 69600 (Advanced Projects) and ECE 69700 (Directed Reading) are not to appear on the Ph.D. plan of study and cannot be used to fulfill any of the Ph.D. requirements. Core course requirements for direct PhD admits can only be satisfied by taking the courses at IUPUI or PUWL.

Primary Area	Core Courses
Automatic Control	ECE 60200
Communications/Signal Processing	ECE 60000
Computer Engineering	ECE 60800
VLSI and Circuit Design	ECE 60600 or ECE 60800
Power	ECE 61000

Table 1: ECE core courses

Minimum Number of credit hours	90
Minimum number of graduate courses credit hours in ECE	39
Minimum number of Core courses credit hours	6
Minimum number of credit hours in primary area	18
Minimum number of ECE courses credit hours \geq 61100	6

Table 2: Summary of Ph.D. credit hour requirements for Direct Admits

Students enrolled in the Ph.D. program after the completion of a Master’s degree may be able to apply some of their Master’s degree course credits toward the Ph.D. degree. Evaluation of eligible Masters credit hours will be conducted on a case-by-case basis by the Head of the ECE Graduate program (Chair

of the ECE Department) in consultation with the ECE Graduate Committee. A summary of the requirements in this case is shown in Table 3.

Minimum Number of credit hours	90*
Minimum number of graduate credit hours in primary area	18
Minimum number of course credit hours taken after MS degree	18
Minimum number of ECE course credit hours \geq 61100 taken after MS degree	6

Table 3: Summary of Ph.D. credit hour requirements for student who were admitted with Masters degree

* based on case-by-case evaluation course evaluation, some or all of the credits hours from of the Master degree may be applied towards the Ph.D. degree.

Full-time status requires enrollment in 8 credit hours per semester (fall and spring). Students who are employed 16-20 hours per week on a Student Academic Appointment are required to enroll in a minimum of 6 credit hours per semester to maintain full-time status. Typically, Ph.D. students enroll in 6-10 credit hours (combined coursework and/or research credits) up through the semester in which they complete their coursework and pass qualifying examinations. Once the student has completed all coursework, enrollment in nine-to-twelve ECE 69900 research credit hours per semester is typical. A Ph.D. student should be able to complete the program in 4-5 years (8-10 semesters). A sample plan of study is attached.

The Doctoral Advisory Committee consists of at least four members. The primary duties of this committee is to assist in the preparation of the student’s final plan of study, to advise the student during the course of their thesis research, and to conduct their Preliminary and Final Examinations. The Major Professor serves as chairperson of the Doctoral Advisory Committee.

In most cases, the Major Professor and the student choose the other members who will serve with the Major Professor on the Doctoral Advisory Committee. Membership of the committee must satisfy:

- The chairperson and at least two other members must be IUPUI ECE faculty members
- The chairperson and at least one other member should be members of the Primary Area that the student has declared.
- If two advisors guide a student’s research jointly, then it is possible to have two co-chairs on Doctoral advisory committee rather than a single chair. At least one of the co-chairs must be a member of the IUPUI ECE faculty and should be a member of the Primary Area that you have declared.

The Qualifying Examination (QE) is a written examination required of all ECE doctoral students. It is a four-hour closed-book exam that will be offered once a year during summer (approximately two weeks before the start of the Fall semester). Questions on the exam are topics based; i.e., based on fundamental area-related topics. Each area specifies a group of at least two (2) area-approved topics which form the basis for exam questions. Students are required to answer two (2) questions in their declared Primary Area and one question from a Secondary Area (the Secondary area is a second area selected from the list of 5 given on page 1). The fourth question may be in the Primary or Secondary area. A reading list and prior exam test questions are made available to the students. Students with an MS degree are required to take the QE at the first offering of the exam after their entry into the PhD program. Direct PhD students must take the QE after having completed two academic-year semesters in the program. Subsequent retakes of the QE must be at the next offering of the exam.

There is a limit of number of times a student can take the QE. Students can take the QE two times. If a student is not successful in passing the QE on their first two attempts, the student can appeal to the ECE

Graduate committee to take the QE a third time. If the appeal is not successful or if they fail a third time the student would be dismissed.

Each student must successfully complete the QE process, including any remedial work, before he/she is permitted to take the PhD Preliminary Examination. During the Fall semester students will be informed of the area approved topics for the QE exam that takes place in the following summer. During the Spring semester, students expected to take the QE must confirm their participation with the ECE Department. Record the areas over which they are to be tested. The ECE Department is to be informed as soon as possible if circumstances beyond the student's control will cause the student to miss the exam. Performance on the examination is evaluated as follows:

- ≥ 70% – The QE requirement is satisfied;
- ≥ 60% but less than 70% – Conditional Pass with required remediation;
- < 60% – Retake the entire exam with recommended remediation.

In all cases (including Pass) the overall and individual question scores are transmitted to members of the student's advisory committee. When remediation is required or recommended, the student's advisory committee is to meet to propose a remediation plan. Possible options:

- a) Passing a specified course(s) with a grade of B or better;
- b) Auditing a previously taken course(s) for a set period of time (say 5-7 weeks) while assembling a set of relevant course notes and completed homework problems;
- c) Other options as approved by the Graduate Committee.

Option a) is the preferred option when there are individual question scores of less than 50% and/or more than one Primary Area test question score of less than 70%.

Before required remediation is initiated, it must be approved (checked for compliance with accepted remediation activities) by the Head of the ECE Graduate Program (chair of the ECE department) and the approved remediation is recorded by the ECE Department. When a proposed remediation consists of something other than passing a course, the student's major professor is responsible for having the student submit a report of completed remediation work to the ECE Department. Although considered an unlikely occurrence, students have the option of retaking the QE instead of performing the required remediation.

The Preliminary Examination is given to determine whether a student is adequately prepared to conceive and undertake a suitable research topic. Students may not schedule their Preliminary Examination until after they have passed the Qualifying Examination and submitted their final plan of study. The Preliminary Examination may include a written exam component, if the Doctoral Advisory Committee so requires, but normally it is an oral examination primarily associated with a written thesis proposal.

To ensure academic progress, the Preliminary Examination is to be taken by PhD students with an MS after no more than six semesters in the PhD program and by direct PhD students after no more than eight semesters in the program. If this deadline is not met, students must request an extension of the deadline using a form available in the ECE Department. The reason(s) for the delay in taking the Preliminary Examination and specific actions planned to remedy the situation must be indicated on the form. The form must be signed by all members of the Doctoral Advisory Committee and the Head of the ECE Graduate Program. A completed form is required each semester past the deadline before registration for the subsequent semester is allowed.

The PhD thesis must be formatted according to Purdue Graduate School and ECE requirements. Once the thesis is prepared and all other requirements have been completed, the student must present and defend

his/her work in a Final Examination. The Final Examination Committee is typically just the student's Doctoral Advisory Committee.

b) Exceeding the Standard Expectation of Credit Hours

Not applicable.

c) Program Competencies of Learning Outcomes

The Learning Outcomes for the proposed site-approved Ph.D. degree program in Electrical and Computer Engineering are:

1. Synthesize and apply an in-depth knowledge of general fundamental concepts (e.g., signal and image processing, communication systems, networking, wireless systems, electronic analysis and design methodologies, VLSI design, control systems, modern automatic control systems, multivariable and robust control, power and energy systems, energy conversion, software engineering, computer architecture, algorithms, programming languages, operating systems, etc.).
2. Develop the mastery of Electrical and Computer Engineering in at least one sub-discipline of Electrical and Computer Engineering.
3. Integrate sub-disciplines of Electrical and Computer Engineering and other disciplines as applicable in problem solving and research.
4. Search, read and synthesize peer-reviewed literature, and apply acquired knowledge in the selected field of study.
5. Present and communicate research results and findings to peers through international conference, posters, seminars and/or journal publications.
6. Develop skills to design solid methodologies, algorithms/techniques/systems, and experiments to solve general problems with real data.
7. Develop new methodologies and systems through critical and creative thinking processes.
8. Propose and conduct original research independently.
9. Communicate and Defend original scholarly works.

d) Assessment

For the assessment of student applications and degree progress, the on-site ECE Ph.D. at IUPUI will be based on the following metrics:

- Number of applicants and admitted students,
- Number of students matriculating in the program,
- Number of students supported by grants and other institutional sources,
- Academic profiles of attendees (GPAs, GRE scores, graduate degrees, previous institutions attended, ranking in previous institution),
- Student performance in course work,
- Student research productivity (number of publications and presentations),
- Awards and other special recognition,
- Time to degree completion,
- Number of graduating students , and
- Student placement: Number of student employed and quality of placements

Monitoring the above metrics will be the responsibilities of the Head of the ECE Graduate program (ECE department chair) and the ECE Graduate Committee. Each year, in early fall, the relevant data from the previous year will be collected and summarized. Each annual enrollee will be followed through to

graduation; course and research work performance will be monitored on a semester-by-semester basis. To allow for a long-term assessment of the program, awards and job placement will be followed for three to five years post-graduation. Ongoing regular assessment will also include the level of external research funding and institutional support.

e) Licensure and Certification

The Ph.D. program is not intended to prepare students for any specific licenses/certifications.

f) Placement of Graduates

Ph.D. students have access to career services provided by the School of Engineering & Technology, as well as the career services at Purdue University West Lafayette (our current masters students utilize the PUWL career services).

Appendix A: Supplementary Pre-proposal Documentation

A-1. Letter of Endorsement from Purdue West Lafayette corresponding program

All pre-proposals must include an endorsement from the head of the corresponding West Lafayette school and dean of the college at Purdue West Lafayette for the request to award site specific doctoral degrees at the metropolitan campus.

Attached is a letter of support for the on-site PhD at IUPUI co-signed by the ECE PUWL department head, Dr. Venkataramanan Balakrishnan and the Dean of Engineering Dr. Leah Jamieson

Leah H. Jamieson
The John A. Edwardson Dean of Engineering
Ransburg Distinguished Professor
of Electrical & Computer Engineering

August 10, 2016

Brian King, Ph.D.
Associate Professor and Acting Chair
Department of Electrical and Computer Engineering
IUPUI
799 W. Michigan Street
Indianapolis, IN 46202

Dear Professor King:

The College of Engineering and the School of Electrical and Computer Engineering at Purdue's West Lafayette campus support the proposal to award a site-specific doctoral degree in Electrical and Computer Engineering at Indiana University-Purdue University Indianapolis, with the understanding that both the diploma and the transcript will clearly state that the degree is awarded for work at the Indianapolis campus.

Faculty members in the School of Electrical and Computer Engineering (ECE) are ready to work with you and your faculty as you launch your program. Joint efforts could include such activities as research proposals, seminars, and service on graduate student advisory committees. We have also recently agreed to the Graduate School's new policy that applicants to the ECE graduate program at West Lafayette who could not be accommodated on this campus may apply to a graduate program at another Purdue campus at no charge. ECE receives nearly 2,000 applications for graduate programs each year and can enroll only a small fraction of those students.

In addition, Audeen Fentiman, Associate Dean of Engineering for Graduate Education and Interdisciplinary Programs, who has been involved in development of other proposals for new graduate programs in engineering, will be happy to work with you, if you like, as you prepare the pre-proposal and proposal. We wish you success with this endeavor.

Sincerely,



Leah H. Jamieson
The John A. Edwardson Dean of Engineering
Ransburg Distinguished Professor of
Electrical and Computer Engineering



Venkataramanan Balakrishnan
The Michael and Katherine Birck Head and
Professor of Electrical and Computer
Engineering



Office of the Dean

A-2. Demand

Evidence should be included that demonstrates current and sustained demand for individuals with doctoral degrees in this discipline.

GUIDELINE

Letters should be included from at least three employers interested in hiring graduates of the program over several years.

GUIDELINE

In the *NACE Job Outlook Survey for 2016* (National Association of Colleges and Employers)², the top five doctoral degrees for which employers expressed their greatest need are in order: i) Electrical Engineering, ii) Computer Science, iii) Software Engineering, iv) Computer Engineering and iv) Mechanical Engineering, with the last two being tied.

Attached are letters of support from industries that would be interested in recruiting our PhD graduates. Two of the industries Allen Institute and NVidia are currently employing Purdue ECE PhD graduates who graduated from the IUPUI campus.

² <http://www.naceweb.org/>



615 Westlake Ave N.
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206.548.7000 phone

Hanchuan Peng
Associate Investigator
Head, Computational NeuroAnatomy
hanchuanp@alleninstitute.org
206.548.8416

July 30, 2016

David J. Russomanno, Ph.D.
Dean, Purdue School of Engineering and Technology, IUPUI
Indiana University-Purdue University Indianapolis
799 W. Michigan Street, ET 219 E
Indianapolis, IN 46202-5160

Dear Dr. Russomanno,

I am pleased to write in strong support of your School's proposal for an IUPUI site-approved Ph.D. program in Electrical and Computer Engineering. My colleagues at Allen Institute for Brain Science and I have been pleased to witness the emergence of the School of Engineering and Technology at Indiana University Purdue University Indianapolis (IUPUI) as an excellent research and learning academic partner.

We have hired several ECE graduates including Ph.D. students from IUPUI and have found them to be highly skilled. We strongly believe that a site-approved Ph.D. program will complement the continuum of the already successful site-approved B.S. and M.S. programs at IUPUI. In addition, the proposed program has an excellent potential to provide us with a larger pool of advanced engineering talent that can help us fill our projected hiring needs.

We further believe that approval of the site-approved status you are requesting will have a broader impact as it will make the aforementioned IUPUI programs more competitive for external funding and in national rankings.

We look forward to the proposed site-approved Ph.D. program. Please keep us informed when highly talented candidates become available in the job market.

Sincerely,

A handwritten signature in black ink that reads "H. C. Peng".

Dr. Hanchuan Peng
Allen Institute for Brain Science
Seattle, WA, USA.



July 11, 2016

David J. Russomanno, Ph.D.
Dean, Purdue School of Engineering and Technology, IUPUI
Indiana University-Purdue University Indianapolis
799 W. Michigan Street, ET 219 E
Indianapolis, IN 46202-5160

Dear Dr. Russomanno,

I am pleased to write in strong support of your School's proposal for an IUPUI site-approved Ph.D. degree program in Electrical and Computer Engineering. My colleagues at Cummins and I have been pleased to witness the emergence of the School of Engineering and Technology at IUPUI as an excellent research and learning academic unit and key asset in our shared ambition to make Indiana a hub of discovery and innovation. IUPUI graduates of the current Ph.D. program awarded through the West Lafayette campus hold important positions in our company. We have benefitted from the outstanding education they received. Clearly, you are ready to extend the current Ph.D. arrangement IUPUI has with the Purdue, West Lafayette campus to an IUPUI site-approved Ph.D. program.

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. at IUPUI. 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 engineers 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 and development. This experiential learning helps develop important skills that Indiana employers seek in new hires. Enriching the research environment by solidifying the Ph.D. degree program to complement the existing site-approved B.S. and M.S. programs at IUPUI will further improve the education and preparation of your graduates.

I believe that approval of the site-approved 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 site-approved doctoral degrees. All of us in Indiana's engineering community, and other contributors to our economy and quality of life, will share the benefits.

Sincerely,

A handwritten signature in blue ink that reads "Wayne A. Eckerle".

Wayne A. Eckerle, Ph.D.
Vice President Corporate Research and Technology

Wayne A. Eckerle
Vice President
Corporate Research and Technology

Cummins Inc.
1900 McKinley Ave., MC 50125
Columbus, IN 47201 USA

Phone 1 812 377 8615
cummins.com
wayne.a.eckerle@cummins.com



July 14, 2016

David J. Russomanno, Ph.D.
Dean, Purdue School of Engineering and Technology, IUPUI
Indiana University-Purdue University Indianapolis
799 W. Michigan Street, ET 219 E
Indianapolis, IN 46202-5160

Dear Dr. Russomanno,

I am pleased to write in strong support of your School's proposal for an IUPUI site-approved Ph.D. degree program in Electrical and Computer Engineering. The Indiana Automotive Council has been pleased to witness the emergence of the School of Engineering and Technology at IUPUI as an excellent research and learning academic unit and key asset in our shared ambition to make Indiana a hub of discovery and innovation. Developing strong collaborative relationships among universities and the automotive industry is important in Indiana. The Transportation Active Safety Institute, proves the extensive research capability at IUPUI. This institute conducts world class research on advanced driver assistance systems. Institutes such as TASI provide an excellent opportunities for PhD students to conduct and gain valuable research experience that is directly translatable to industry.

We also realize that your undergraduate degree students (the vast majority of whom are from Indiana) enjoy opportunities to have significant engagements in research and development. This experiential learning helps develop important skills that Indiana employers seek in new hires. Enriching the research environment by solidifying the Ph.D. degree program to complement the existing site-approved B.S. and M.S. programs at IUPUI will further improve the education and preparation of your graduates.

I believe that approval of the site-approved 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 site-approved doctoral degrees. All of us in Indiana's engineering community, and other contributors to our economy and quality of life, will share the benefits.

Sincerely,

A handwritten signature in blue ink, appearing to read 'Matthew Conrad', is written over a horizontal line.

Matthew Conrad
Director

July 13, 2016

David J. Russomanno, Ph.D.
Dean, Purdue School of Engineering and Technology, IUPUI
Indiana University-Purdue University Indianapolis
799 W. Michigan Street, ET 219 E
Indianapolis, IN 46202-5160

Dear Dr. Russomanno,

I am pleased to write in strong support of your School's proposal for an IUPUI site-approved Ph.D. degree program in Electrical and Computer Engineering. My colleagues at Raytheon and I have been pleased to witness the emergence of the School of Engineering and Technology at IUPUI as an excellent research and learning academic unit and key asset in our shared ambition to make Indiana a hub of discovery and innovation. IUPUI graduates of the current Ph.D. program awarded through the West Lafayette campus hold important positions in our company. We have benefitted from the outstanding education they received. Clearly, you are ready to extend the current Ph.D. arrangement IUPUI has with the Purdue, West Lafayette campus to an IUPUI site-approved Ph.D. program.

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. at IUPUI. 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 engineers 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 and development. This experiential learning helps develop important skills that Indiana employers seek in new hires. Enriching the research environment by solidifying the Ph.D. degree program to complement the existing site-approved B.S. and M.S. programs at IUPUI will further improve the education and preparation of your graduates.

I believe that approval of the site-approved 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 site-approved doctoral degrees. All of us in Indiana's engineering community, and other contributors to our economy and quality of life, will share the benefits.

Sincerely,



John Moore
Engineering Fellow
Department Manager, Electrical & Mechanical Engineering

July 26, 2016

**Toyota Motor Engineering &
Manufacturing North America, Inc.**
1555 Woodridge Ave
Ann Arbor, MI 48105
734-995-2600

David J. Russomanno, Ph.D.
Dean, Purdue School of Engineering and Technology, IUPUI
Indiana University-Purdue University Indianapolis
799 W. Michigan Street, ET 219 E
Indianapolis, IN 46202-5160

Dear Dr. Russomanno,

I am pleased to write this letter in support of your School's proposal for an IUPUI site-approved Ph.D. degree program in Electrical and Computer Engineering. My colleagues at Toyota and I have been pleased to witness the emergence of the School of Engineering and Technology at IUPUI as an excellent research and learning academic unit. Our strong collaborative relationship with the Transportation Active Safety Institute, proves the extensive research capability at IUPUI. This institute conducts excellent research on advanced vehicle active safety systems. Institutes such as TASI provide excellent opportunities for PhD students to conduct and gain valuable research experience.

We also realize that your undergraduate degree students (the vast majority of whom are from Indiana) enjoy opportunities to have significant engagements in research and development. This experiential learning helps develop important skills that employers seek in new hires. Enriching the research environment by solidifying the Ph.D. degree program to complement the existing site-approved B.S. and M.S. programs at IUPUI will further improve the education and preparation of your graduates.

I believe that approval of the site-approved 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 site-approved doctoral degrees. All of us in engineering community, and other contributors to our economy and quality of life, will share the benefits.

Sincerely,



Rini Sherony
Sr. Principal Engineer
Collaborative Safety Research Center
Toyota Motor Engineering & Manufacturing North America
Ph: (734) 995-7116
rini.sherony@toyota.com

A-3. Coursework

All courses must have been reviewed and approved by the Purdue Graduate Council within a reasonable period of time following the submission of the pre-proposal. A sample plan of study reflecting each primary area of study within a department should be included. The policies of the Graduate School apply to all plans of study.

A table reflecting departmental courses that indicates how frequently the courses have been and are to be offered should be part of the pre-proposal.

Both the core courses required in a discipline and the coursework in areas of research focus must be available consistently at the campus that is requesting site approval.

GUIDELINE

Graduate coursework used on a plan of study should be offered at least every other year, as a minimum. Basic courses should be offered each semester or each year to allow students to progress through the program without delay.

Below indicates courses offered in ECE at IUPUI. We have a fairly substantial masters program and so we have substantial graduate course offerings each semester. In the course list we indicate the intended frequency we plan to offer. We also describe the past course offering, indicating semester and year.

Course No. & Name	No. times taught in last five years	Frequency to be Taught	Comments
ECE 53200 Computational Methods for Power System Analysis	Spr 13, Spr14, Spr15, Spr16	Every Spring	
ECE 53301 Wireless and Multimedia Computing	Fa12, Fa13, Fa14, Fa15, Fa16	Every Fall	
ECE 53700 Multimedia Applications	Fa12, Fa13, Fa14, Fa15, Fa16	Every Fall	
ECE 53800 Digital Signal Processing Application	Spr12, Spr13, Spr14, Spr15, Spr16	Every Spring	
ECE 54400 Introduction to Digital Communications	Spr14, Fa 16	Once every two years	
ECE 54700 Introduction to Computer Communication Networks	Fa12, Fa13, Fa14, Fa15, Fa16	Every Fall	
ECE 55400 Electronic Instrumentation and Circuit	Sum13, Spr14, Spr15	Every Spring	
ECE 55900 MOS VLSI Design	Fa13, Fa15	Once every two years	
ECE 56401 Computer Security	Fa 11	Once every two years	To be scheduled Fa 17
ECE 56500 Computer Architecture	Spr12, Spr13, Spr14, Spr15, Spr16	Every Spring	
ECE 56900 Introduction To Robotic Systems	Fa 14, Fa 15, Fa 16	Once every two years	

ECE 57000 Artificial Intelligence	Spr15, Fa 16	Once every two years	
ECE 58000 Optimization Methods for Systems and Control	Fa12, Fa13, Fa14, Fa15, Sp16	Every Spring	
ECE 59500 Real-time Operating Systems and Application	Fa12, Fa15	Once every two years	Request for a permanent number has been submitted
ECE 59500 Automotive Control	Fa12, Fa13, Spr15, Spr16	Every Spring	
ECE 59500 Wireless Network Security	Spr15	Once every two years	
ECE 59500 Advanced Power Electronics Converters	Fa 13, Fa 14, Sum 15, Spr 16	Every year	Request for a permanent number has been submitted
ECE 59500 Advanced Systems on a Chip (SoC) Designs for Image Processing using FPGAs	Spr14, Spr16	Once every two years	Request for a permanent number has been submitted
ECE 59500 Design with Embedded and Digital Signal Processors	Spr15, Spr 16	Every Spring	New course
ECE 59500 Foundations of Adv. Engineering I	Sum12, Sum13, Sum14, Sum16	Once every two years	Request for a permanent number has been submitted
ECE 59500 System Modeling & Design for Smart Devices	Spr12, Fa 15	Once every two years	Request for a permanent number has been submitted
ECE 59500 Special Topics in Discrete Event Dynamic Systems	Spr12, Spr13, Spr14, Fa 15	Every Spring	Request for a permanent number has been submitted
ECE59500 Statistical Signal Processing	Spr15, Spr 16	Once every two years	
ECE 595000 Architecture and Computing Trends in Parallel and Distributed Systems	Spr 16	Every Spring	New course
ECE 595000 Database Systems	Fa14, Sp16	Once every two years	

ECE 59500 Nanosystems Principles	Fa 12, Fa13, Fa 14, Fa 15, Fa16	Every fall	Request for a permanent number is being processed
ECE 59500 Integrated Nanosystems Processes and Devices	Spr12, Spr13, Spr14, Spr15, Spr16	Every Spring	Request for a permanent number is being processed
ECE 59500 Introduction to Smart Grid	Sum16	Once every two years	
ECE 60000 Random Variables	Fa12, Fa13, Fa14, Fa15, Fa16	Every Fall	
ECE 60200 Lumped System Theory	Fa12, Fa13, Fa14, Fa15, Sp16	Every Spring	
ECE 60800 Computational Models & Methods	Spr12, Spr13, Spr14, Spr15, Spr16	Every Spring	
ECE 61000 Energy Conversion	Spr12, Spr13, Spr14, fa15, Fa16	Every Fall	
ECE 62700 Introduction to Cryptography & Secure Communications	F12 12, Fa14, Fa16	Once every two years	
ECE 63700 Digital Image Processing I		Once every two years	Course taught once at IUPUI, developed ECE 5XX 2D-3D imaging class We have offered that regularly. With an on-site PhD we will alternate 637 with the 5XX class.
ECE 66200 Pattern Recognition and Decision Making Processes	Fa13, Fa14, Fa16	Every Fall	
ECE 68000 Modern Control Theory	Spr12, Spr13, Spr14, Fa15	Every Fall	
ECE 68400 Linear Multivariable Control	Spr15	Once every two years	
ECE 69500 Error Control Coding	Fa13, Fa15	Once every two years	
ECE 69500 Mobile Wireless Networking	Spor12, Spr13, Spr14, Fa 16	Once every two years	

A-4. Admissions

The admission standards must be clearly stated for students and must be in compliance with the Graduate School minimum requirements.
GUIDELINE

In most cases, the admission standards would be the same as those applied by the corresponding West Lafayette program.

A table must be included which reflects: (1) the number of enrolled students for the past five years; and (2) the number of in-state, out-of-state, and international students for the past five years.

GUIDELINE

The minimum number of doctorally-enrolled students on average over the past five years should be no lower than 10 students or a justification for the number of students should be provided. (This number could include M.A./M.S. students on a doctoral track.)

The Admission standards will follow Purdue Graduate School standards. The ECE department will implement departmental review of applicants using a comparable level of accomplishment/requirements that ECE at PUWL employs. Members of the ECE department at IUPUI have participated in the ECE-PUWL admission process as observers for more than 10 years.

A-5. Tenure-Track Faculty

A pre-proposal should reflect the number of tenure-track faculty who are approved to be graduate committee chairs in the program. (A proposal must include a 2-3 page NSF style bio for all participating faculty; these faculty should be eligible for regular graduate faculty status by the Graduate School. Graduate School policy requires that 51% of a student's advisory committee have regular graduate faculty status. There must be an adequate number of faculty to populate all graduate committees with a reasonable faculty workload.)

GUIDELINE

Programs should reflect an adequate number of tenure-track faculty members to populate student committees.

The ECE department counts 17 tenure-track/tenured faculty and 1 lecturer. In addition, the department includes 4 adjunct professors who are active as co-advisers/ members of thesis committees of several thesis students. The faculty distribution is comprised of eight Professors, eight Associate Professors, one Assistant Professor, and one lecturer. Faculty honors include an inductee to the Consumer Electronics Hall of Fame, two NSF Career Award recipients. In addition, several faculty members hold patents and numerous have extensive prior industrial R&D experiences.

In section A-7 we provide a two-page bio for each of our faculty.

Our faculty consists of:

Zina Ben Miled, PhD, Associate Professor. She received her PhD from Purdue University in 1997. Her research areas of interest include large enterprise software systems, distributed storage & processing, data analytics, business intelligence and time critical applications.

Chen, Yaobin, PhD, Professor and Director of Transportation Active Safety Institute. He received his PhD from Rensselaer Polytechnic Institute in 1988. His current research interests are modeling, simulation, optimization and control of advanced automotive systems, intelligent transportation and vehicle systems, and computational intelligence applications.

Chien, Stanley, PhD, Professor. He received his PhD from Purdue University in 1989. His research interests are Robotics and automation, intelligent robot systems, as well as object-oriented programming and high performance computing for embedded systems and real time applications.

Christopher, Lauren, PhD, Assistant Professor. She received her PhD from Purdue University in 2003. Her research interests are application of VLSI circuits to 3D imaging algorithms to improve throughput and real-time analysis of 3D image data.

Dos Santos, Euzeli, PhD, Assistant Professor. He received his PhD from Federal University of Campina Grande, Campina Grande – PB, Brazil. His research interests are power electronics, renewable energy system and motor drive systems.

El-Sharkawy, Mohamed, PhD, Professor. He received his PhD from Southern Methodist University in 1985. His research interests include digital signal processing, voice recognition, graphics and image processing, coding, modulation, equalization, and parallel processing for signal and imaging applications.

Kim, Dongsoo, PhD, Associate Professor. He received his PhD from the University of Minnesota in 1998. His research interests include computer communication networks, wireless mobile networks, performance measurements, and real-time operating systems.

King, Brian, PhD, Associate Professor and Chair. He received his PhDs in 1990 and 2000, respectively, from University of Wisconsin-Milwaukee. His research interests include Information security, computer

and network security, wireless security, cryptography, ubiquitous and mobile ad-hoc network Security, algorithms, and applied mathematics.

Koskie, Sarah, PhD, Associate Professor. She received her PhD from Rutgers University in 2003. Her research interests include control theory, system identification, game theory, and their applications, including communication, automotive, biological, and aerospace.

Lee, Jaehwan (John), PhD, Associate Professor. He received his PhD from Georgia Institute of Technology in 2004. His current research interests include FPGA-assisted data streaming and processing, computer architecture simulation, , multiprocessor system-on-chip design, and real time hardware implementations of complex algorithms.

Li, Lingxi, PhD, Associate Professor. He received his PhD from the University of Illinois in 2008. His research interests include fault-tolerant control of complex systems, discrete event systems, and intelligent transportation systems.

Rizkalla, Maher, PhD, Professor and Associate Chair. He received his PhD from Case Western Reserve University in 1985. His research interests include applied superconductivity, solid state electronics, VLSI, signal processing and electronics manufacturing.

Rovnyak, Steven, PhD, Associate Professor. He received his PhD from Cornell University in 1994. His interests include pattern recognition methodologies for protective relaying and for one-shot stability controls in electric power systems; distributed generator control, dynamic systems, signal processing and pattern recognition applications.

Russomanno, David, PhD, Professor and Dean. He received his PhD from the University of South Carolina in 1993. His research interests include intelligent sensors and supporting software infrastructure, knowledge representation and inference, and STEM research.

Salama, Paul, PhD, Professor. He received his PhD from Purdue University in 1999. His research interests include signal/image/video processing, biomedical image analysis, image/video compression, security, and restoration/reconstruction, digital communications, information theory and source coding, error resilience and error concealment.

Schubert, Peter, PhD, Professor and Director of the Lugar Center for Renewable Energy. He received his PhD from Purdue University in 1990. His research interests include renewable energy from biomass and waste, hydrogen generation, hydrogen storage, ultra-high temperature ceramics, space-based manufacturing, public policy, government systems, and multidisciplinary research.

Shayesteh, Seemein, MS, Lecturer. She received an MS in Electrical Engineering from The University of Toledo in 1998.

Varahramyan , Kody, PhD, Professor and Special Adviser to the Chancellor. He received his PhD from Rensselaer Polytechnic Institute. His Research interests are Nano electronics and micro manufacturing.

The bios of tenure/tenure track faculty are attached.

A-6. Funding and Research Support

Proposals should provide a table that reflects the type of support for each student over the past five years—research assistantship, teaching assistantship, fellowship funding, or self-supported—and the campus from which the funding originated.

Proposals should include a list of the active faculty grants.

GUIDELINE

Funding for students should reflect research and teaching assistants as well as internal and external fellowships originating at the campus seeking approval.

In this section we provide the following information.

1. We list our PhD graduates, where they work and their job title.
2. We list our PhD students for the last five years.

We now provide a list of our PhD graduates and where they work.

Name	IUPUI Adviser	Graduate is working at	Job title
LIU, CHAO	L. Christopher	University Colorado Denver	Assistant Professor CTT, Electrical Engineering
YANG, KAI	E. Du	Epic	
Vaidya, Pranav	J. Lee	Nvidia	Senior Software Engineer
Maina Ari, Adam	L. Li	Whirlpool	
Banvait, Harpreet	Y. Chen	Ford Research	
Bowen, Francis	E. Du	Silicis technologies inc	Electronics and Software Manager
Zhou, Zhi	E. Du	Allen Institute	Scientist II
Xiao, Xiang	J. Lee	Airbnb	Principal engineer

The list of ECE PhD students at IUPUI for the last five years is provided below.

STUDENT	ADVISER(s)	PROGRAM START DATE
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Fall 2016

Aliahmad, Nojan	Rizkalla/Agarwal	Fall 2013
Alibeik, Maryam	SANTOS	Fall 2014
Cong, Shan	RIZKALLA	Fall 2014
Daneshkhah, Ali	Varahramyan	Fall 2011
Deng, Qiwen	Chen	Fall 2016
Emerson, David	Christopher	Fall 2015
Gao, Tianchong	Chien/ F. Li	Fall 2015
Jiang, Feng	King	Fall 2012
Lotfalizadeh, Hamidrez	Ben Miled	Fall 2016
Mao, Songan	Chien/ H. Wu	Fall 2013
Nezamuddin, Omar	Dos Santos	Spring 2015
Ruan, Keyu	LI	Fall 2015
Shen, Dan	Chen	Fall 2016
Tanksale, Vinayak	King	Fall 2013
Xue, Jie	CHEN	Fall 2011
Yaqub, Omar	Koskie	Fall 2013

Spring 2016

Aliahmad, Nojan	Rizkalla/Agarwal	Fall 2013
Alibeik, Maryam	Dos Santos	Fall 2014
Cong, Shan	RIZKALLA	Fall 2014
Daneshkhah, Ali	Varahramyan	Fall 2011
Emerson, David	Christopher	Fall 2015
Gao, Tianchong	Chien/ F. Li	Fall 2015
Jiang, Feng	King	Fall 2012
Liu, Chao	Christopher	Fall 2011
Mao, Songan	Chien/ H. Wu	Fall 2013
Nezamuddin, Omar	Dos Santos	Spring 2015
Ruan, Keyu	LI	Fall 2015
Tanksale, Vinayak	King	Fall 2013
Vaidya, Pranav	Lee	Fall 2005
Xue, Jie	CHEN	Fall 2011
Yaqub, Omar	Koskie	Fall 2013
Yang, Kai	Du	Fall 2011

Fall 2015

Aliahmad, Nojan	Rizkalla/Agarwal	Fall 2013
Alibeik, Maryam	Dos Santos	Fall 2014

Cong, Shan	RIZKALLA	Fall 2014
Daneshkhah, Ali	AGARWAL/Rizkalla	Fall 2011
Gao, Tianchong	Chien/ F. Li	Fall 2015
Jiang, Feng	King	Fall 2012
Liu, Chao	L.Christopher	Fall 2011
Mao, Songan	Chien/ H. Wu	Fall 2013
Nezamuddin, Omar	Dos Santos	Spring 2015
Ruan, Keyu	LI	Fall 2015
Tanksale, Vinayak	King	Fall 2013
Vaidya, Pranav	Li	Fall 2005
Xue, Jie	CHEN	Fall 2013
Yang, Kai	Du	Fall 2011
Yaqub, Omar	Koskie	Fall 2013

Spring 2015

ALIAHMAD, NOJAN	Rizkalla/Agarwal	Fall 2013
ALIBEIK, MARYAM	Dos Santos	Fall 2014
Alwajeih, Rayed	Li	Fall 2013
CONG, SHAN	RIZKALLA	Fall 2014
DANESHKHAH, ALI	Varahramyan	Fall 2011
JIANG, FENG	KING	Fall 2012
LIU, CHAO	Christopher	Fall 2011
MAO, SONGAN	Chien/ H. Wu	Fall 2013
Nezamuddin, Omar	Dos Santos	Spring 2015
Tanksale, Vinayak	King	Fall 2013
Vaidya, Pranav		Fall 2005
XUE, JIE	CHEN	Fall 2013
YANG, KAI	CHEN	Fall 2011
YAQUB, OMAR	KOSKIE	Fall 2013

Fall 2014

ALIAHMAD, NOJAN	Rizkalla/Agarwal	Fall 2013
ALIBEIK, MARYAM	Dos Santos	Fall 2014
Alwajeih, Rayed	Li	Fall 2013
CHEN, MINGYE	Chen	Fall 2013
CONG, SHAN	RIZKALLA	Fall 2014
DANESHKAH. ALI	Varahramyan	Fall 2011
JIANG, FENG	KING	Fall 2012

LIU, CHAO	Christopher	Fall 2011
MAO, SONGAN	Chien/ H. Wu	Fall 2013
Shi, Tuo	Lee	Spring 2008
Tanksale, Vinayak	King	Fall 2013
Vaidya, Pranav	Lee	Fall 2005
XIE, JIE	CHEN	Fall 2013
YANG, KAI	Du	Fall 2011

Spring 2014

Aliahmad, Nojan	Rizkalla/Agarwal	Fall 2013
Alwajeih, Rayed	Li	Fall 2013
Ari, Adam Mainia	Li	Fall 2010
Banvait, Harpreet	Y.Chen	Fall 2007
Chen, Mingye	Chen	Fall 2013
Daneshkhah, Ali	AGARWAL/Rizkalla	Fall 2011
Jiang, Feng	King	Fall 2012
Liu, Chao	Christopher	Fall 2011
Maina Ari, Adam	Li	Fall 2011
Mao, Songan	Chien/ H. Wu	Fall 2013
Shi, Tuo	Lee	Spring 2008
Tanksale, Vinayak	King	Fall 2013
Vaidya, Pranav		Fall 2005
Vasquez, Diana	Rovnyak	Spring 2009
Xue, Jie	Chen	Fall 2013
Yang, Kai	Chen	Fall 2011
Yaqub, Omar	Koskie	Fall 2103

Fall 2013

Aliahmad, Nojan	Rizkalla/Agarwal	Fall 2013
Alwajeih, Rayed	Li	Fall 2013
Ari, Adam Mainia	Li	Fall 2010
Banvait, Harpreet	Y.Chen	Fall 2007
Chen, Mingye	Chen	Fall 2013
Daneshkhah, Ali	Varahramyan	Fall 2011
Jiang, Feng	Du	Fall 2012
Liu, Chao	Christopher	Fall 2011
Maina Ari, Adam	Li	Fall 2011
Mao, Songan	Chien/ H. Wu	Fall 2013
Shi, Tuo	Lee	Spring 2008
Tanksale, Vinayak	King	Fall 2013
Vaidya, Pranav	Lee	Fall 2005
Vasquez, Diana	Rovnyak	Spring 2009
Xue, Jie	Chen	Fall 2011
Yang, Kai	Du	Fall 2011

Yaqub, Omar	Koskie	Fall 2013
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Spring 2013

Daneshkhah, Ali	Varahramyan	Fall 2011
Ernst, James	Lee	Fall 2010
Jiang, Feng	Du	Fall 2012
Liu, Chao	Christopher	Fall 2011
Maina Ari, Adam	Li	Fall 2011
Shi, Tuo	Lee	Spring 2008
Vaidya, Pranav	Lee	Fall 2005
Vasquez, Diana	Rovnyak	Spring 2009
Zhou, Zhi	Du	Fall 2006

Fall 2012

Banvait, Harpreet	Y.Chen	Fall 2007
Bowen, Francis	Du	Fall 2007
Daneshkhah, Ali	Varahramyan	Fall 2011
Ernst, James	Lee	Fall 2010
Jiang, Feng	Du	Fall 2012
LIU, CHAO	Christopher	Fall 2011
Maina Ari, Adam	Li	Fall 2011
Ray, Michael	chien	Fall 2012
Shi, Tuo	Lee	Spring 2008
Vaidya, Pranav	Lee	Fall 2005
Vasquez, Diana	Rovnyak	Spring 2009
Xue, Jie	RA, Chen	Fall 2011
Yang, Kai	Du	Fall 2011
Zhou, Zhi	Du	Fall 2006

Spring 2012

Banvait, Harpreet	Chen	Fall 2007
Bowen, Francis	Rizkalla	Fall 2007
Daneshkhah, Ali	Varahramyan	Fall 2011
Ernst, James	Lee	Fall 2010
Hagyousif, Amin	Salama	Spring 2009
Li, Weixu	Christopher	Fall 2011
Liu, Chao	Christopher	Fall 2011
Maina Ari, Adam	RA/TA, Li	Fall 2007
Shi, Tuo	Lee	Spring 2008
Vaidya, Pranav	Lee	Fall 2005
Vasquez, Diana	Rovnyak	Spring 2009
Xue, Jie	RA, Chen	Fall 2011

Yang, Kai	Fellowship, Du	Fall 2011
Zhou, Zhi	Du	Fall 2006

Fall 2011

Banvait, Harpreet	Chen	Fall 2007
Bowen, Francis	Rizkalla	Fall 2007
Daneshkhah, Ali	Varahramyan	Fall 2011
Ernst, James	Lee	Fall 2010
Hagyousif, Amin	TA appt only	Spring 2009
Li, Weixu	Christopher	Spring 2008
Liu, Chao	Christopher	Fall 2011
Maina Ari, Adam	RA/TA, Li	Fall 2007
Shi, Tuo	Lee	Spring 2008
Vaidya, Pranav	Lee	Fall 2005
Vasquez, Diana	Rovnyak	Spring 2009
Xue, Jie	RA, Chen	Fall 2011
Yang, Kai	Fellowship, Du	Fall 2011
Zhou,Zhi	Du	Fall 2006

Spring 2011

Banvait, Harpreet	Chen	Fall 2007
Bowen, Francis	Rizkalla	Fall 2007
Ernst, James	Lee	Fall 2010
Hagyousif, Amin	Salama	Spring 2009
Maina Ari, Adam	Li	Fall 2007
Shi, Tuo	Lee	Spring 2008
Vaidya, Pranav	Dept	Fall 2005
Zhou, Zhi	Du	Fall 2006