Ph.D. Handbook
INTELLIGENT SYSTEMS ENGINEERING
2018-2019
1    INTRODUCTION

Indiana University established the School of Informatics, Computing, and Engineering as a place where innovative multidisciplinary programs could thrive, a program where students can integrate technological skills and computer science methods with diverse disciplines. The School announced a new Doctor of Philosophy (Ph.D.) degree program in Intelligent Systems Engineering beginning in the fall of 2016 and offered on the Bloomington (IUB) campus.

The Doctor of Philosophy in Intelligent Systems Engineering follows the policies described in this document and the University Graduate School Bulletin 2017-2018.

2    PROGRAM DESCRIPTION

Description of program and its objectives:

The Ph.D. in Intelligent Systems focuses on a modern set of engineering topics, namely those that involve intelligent systems, as realized with embedded computing components combined with sophisticated data interpretation.

This program will train students in the practical engineering of systems with an emphasis on hands-on designing, building and simulating systems. Graduates will be prepared with this core set of workforce-aligned skills and will be in high demand for careers in industry, research and academia.

The Ph.D. in Intelligent Systems Engineering is an integrated, multidisciplinary program that encompasses the following fundamental features:

- Focus on smaller scale, often mobile, often personal/consumer technologies and devices, as opposed to engineering that involves large-scale infrastructure and addresses massive structures, plants or systems;
- Incorporation of modern information technology approaches including big data, computational modeling, intelligent systems, and user interface design;
- Incorporation of design principles that make use of synergies in hardware and software, possibly guided by implementations observed in living systems; and
- Cross-disciplinary programming that spans science and technology, from informatics and computing, biology, chemistry, physics, psychological and brain sciences, environmental science and health, and other fields.
3 AREAS OF RESEARCH (TRACKS)

The Ph.D. in Intelligent Systems Engineering is offered in six areas: Bioengineering; Computer Engineering; Cyber-Physical Systems; Environmental Engineering; Molecular and Nanoscale Engineering; and Neuroengineering and a non-track of Intelligent Systems.

**Bioengineering** is a broad field that combines scientific knowledge in the life sciences, computing, and engineering practices to solve problems spanning biology, medicine, environmental remediation, and more. Bioengineering builds on existing IU Bloomington strengths in experimental biology, gene editing, microfluidics, biotransport, biophysics, multiscale computational modeling, and informatics—in order to train the next generation of computing-driven bioengineers.

**Computer Engineering** relates to building computing systems of various scales or building an Internet of Things (IoT) device. It relates to hardware and low-level software, such as device drivers. Within CE, students can mix and match courses to tailor the program toward building big data or deep learning analysis systems, high performance computing systems or the engineering of specialized computing devices.

**Cyber-Physical Systems Engineering** focuses on systems that interact with the physical world directly in some way. CPS is about the entire system including high-level software. Since it is cyber physical, it often emphasizes small or embedded devices. This includes robotics as well as sensor-rich environments like smart homes, smart cars, and smart cities. In all of these cases, the intelligence comes from computing devices. This track could also focus on biosensors.

**Environmental Engineering** develops a strong foundation of practices and challenges by exploring how engineered systems promote better predictions about water quality, climate, and atmospheric conditions. Environmental Engineering will cover fundamental principles of these and other areas to examine unique challenges and opportunities stemming from data analytics, Internet of Things and modern computing.

**Molecular and Nanoscale Engineering** integrates concepts from electrical and materials engineering with nanoscience to prepare students to work with cyber-physical systems or other responsive, intelligent systems that include nanoscale building blocks. Modeling and simulation of nanostructured assemblies, functional nanoparticles, and soft nanosystems is an integral part of this emerging field. Students will take courses that train them in both experimental and computational aspects of nanoengineering and can pursue their interest in sensing technologies, energy devices, nanomedicine, materials discovery, and other areas of study.

**Neuroengineering** is the discipline that studies, enhances, monitors, heals and replicates the nervous system—the principal system of our body that makes us intelligent. Neuroengineers have the unique opportunity to link theories of the mind and application to build intelligent machines and software. Advances in the field will bring about parts for damaged nervous systems, new devices to read brain function, and smart machines to accomplish tasks. As well, microscale devices that couple the nervous systems with physical systems can lead to new cognitive development as well as computations that underlie memory systems.
4 PROGRAM OF STUDY

Students in the doctoral program will explore the connections among technology, theory, social analysis, and application domains in a diverse and multidisciplinary curriculum. This curriculum will include core courses and seminars in Intelligent Systems Engineering; an Intelligent Systems Engineering track (listed above); courses in methodology and theory; electives in related disciplines inside and outside of the school leading to a Ph.D. Minor; and a dissertation.

5 VALUES

We expect students to abide by the spirit as well as the requirements of the Code of Student Rights, Responsibilities, and Conduct (see: http://www.indiana.edu/~code/). This applies to scholarship, any role you may have as an Associate Instructor, relations with colleagues, relations with students, and compliance with academic standards with respect to academic ethics. In particular, if you are not familiar with the concept and best practices to avoid any hint of plagiarism in American universities, please become familiar with these standards before you arrive at the University. The University has provided a series of documents describing the behaviors, ideals, and goals for Indiana University.

6 ADVISING

Students admitted to the Ph.D. Program are assigned an advisor who may be consulted for advice. The Chair of Intelligent Systems Engineering or an assigned faculty advisor are available for general consultation. The student may change advisor upon the consent of the new advisor and by filing documentation with the Intelligent Systems Engineering Graduate Studies Office (GSO). The student must inform the existing advisor of the change. This advisor is the chair of the student’s advisory committee.

No later than one year after admission to the Ph.D. program, each student will consult with appropriate faculty members and designate, with their consent, members of a suitable advisory committee. The advisory committee will guide the student’s doctoral program as well as oversee and conduct the qualifying exam in the student’s research area. The advisory committee must, by University Graduate School rules include, at least two members from the student's major area (track), and at least one from another area (track); at least two must be members of the graduate faculty. The names of the committee members presented by the student will be forwarded to the University Graduate School upon approval by the Chair of the Intelligent Systems Engineering program.

The advisory committee oversees the student's progress until the passing of the qualifying examination, whereupon the student consults with the committee concerning a dissertation advisor. When the student has a dissertation advisor, the student and dissertation advisor identifies members of a suitable research committee (and the advisory committee is abolished). After the members have agreed to serve on the research committee, the appropriate form is filed with the Intelligent Systems Engineering GSO and with The University Graduate School.
The members of the research committee must meet the requirements of the University Graduate School: the committee includes the advisor, normally the professor directing the dissertation, two or more additional faculty members from the School, and must include a representative of any minor. With certain exceptions, the members must belong to the graduate faculty. This committee supervises the dissertation research, conducts the thesis proposal examination, and conducts the Ph.D. thesis defense final examination.

7 CURRICULUM

Credit Hours:
A total of at least 90 credit hours of graduate-level (500+) coursework including:
- at least 24 credits to fulfill the requirements of the ISE major;
- at least 6-12 credits to fulfill the requirements of the University Ph.D. minor; and
- the remaining credits can be received from regular courses, independent studies, and research.

Major (24 Credits)

The major is to be chosen in one of the defined ISE tracks. The major requires 24 credits and includes:
- E500 (1 credits) or equivalent
- One of E501-507 (3 credits) or equivalent
- 9 credits of relevance to major
- 11 other engineering credits

Engineering credits can be satisfied by IU courses in other units with permission of ISE.

Minor (9 credits)

This requirement may be met by a minor approved by the University, or specific courses within the department. In all cases, the number of hours to be included in the minor is consistent with the requirements of the unit granting the minor.

8 MINORS

All students must have either an approved minor outside of Intelligent Systems Engineering or pursue a minor inside the department. External and internal minors should be appropriate to the student’s research as determined by the student’s advisory committee. In all cases, the number of hours to be included in the minor is consistent with the requirements of the unit granting the minor.

9 QUALIFYING EXAMS

There will be a written exam, tailored to each concentration, followed by an oral exam involving the student and his or her advisory committee. The exam will be comprised of questions developed by the faculty and/or a written submission and will be taken after all required coursework has been completed.
The exam will be designed to ensure a student is prepared to start Ph.D. research, and the student must pass this examination before passing on to candidacy. The passing of the Qualifying Examination is based not only on the student's performance on the written and oral examination, but also on his or her performance in coursework and in research. Students must maintain a grade point average of 3.0 or above and achieve a grade of B or better in any research-related coursework.

Details:
- 1-3 Questions agreed by all committee members
- Total length is at least 8 pages in NSF proposal or ACM/IEEE conference formatting. Pictures are allowed
- Time allocated is from one week to 3 months and should be agreed by the committee. The longer time limit must include a publication quality paper.

Committee needs to meet twice (can be virtually). Once to set written exam and once to give oral exam and discuss oral and written exam results.

The qualifying examinations normally will be completed at the end of coursework, before the student embarks on the dissertation; any exceptions are made only by the Chair of the department. The student must pass this examination before passing on to candidacy.

**10 DISSERTATION PROPOSAL**

The research proposal for the dissertation must be approved by the student's research committee. That committee may include the same membership as the advisory committee or the student may choose different members. The advisor for the dissertation will be a faculty member of the ISE department in the School of Informatics, Computing, and Engineering and a member of the Graduate Faculty. Consult the University Graduate School bulletin for the committee member requirements. The student will defend the proposal at a public colloquium in the school.

**11 DISSERTATION AND FINAL DEFENSE**

The culmination of the Ph.D. program is the writing of the dissertation, which is required of all doctoral students. The dissertation must be an original contribution to knowledge and of high scholarly merit. The candidate’s research must reveal critical ability and powers of imagination and synthesis. The dissertation is written under the supervision of a research director and a research committee, as described below. Although work published by the student may be incorporated into the dissertation, a collection of unrelated published papers, alone, is not acceptable. There must be a logical connection between all components of the dissertation, and these must be integrated in a rational and coherent fashion. It is the responsibility of the student’s research committee to determine the kind and amount of published materials which may be included in a dissertation.

Defense of the Dissertation
When the dissertation has been completed, the student should submit an unbound copy to each member of the research committee as the initial step in scheduling the defense of the dissertation. All members of the research committee should read the dissertation in its entirety before attending the
defense. At this stage both the student and the faculty members must extend certain courtesies to each other. It is the responsibility of the student to give faculty members sufficient time to read the dissertation without making unreasonable requests of them based upon University Graduate School time limitations, immediate job possibilities, contract renewal, or some other reason. Similarly, a faculty member should not keep a student’s work for inordinate periods of time because of the press of other duties. Once a faculty member assumes membership on a research committee, it becomes another part of his or her teaching assignment, comparable to conducting regularly scheduled classes.

After the committee members have read the dissertation, there should be direct communication (either in writing or orally) between the research committee chairperson and the other committee members about its readiness for defense. Readiness for defense, however, is not tantamount to acceptance of the dissertation; it means that the committee is ready to make a decision. The decision to hold a doctoral defense, moreover, is not entirely up to the research committee. If a student insists upon the right to a defense before the committee believes the dissertation is ready, that student does have the right to due process (i.e., to an oral defense) but exercises it at some risk.

If the decision to proceed with the defense of the dissertation is made against the judgment of one or more members of the committee, or if one or more members of the committee disapprove of parts of or all of the dissertation, the commit-tee member(s) should not resign from the committee in order to avoid frustration or collegial confrontation. The University Graduate School urges that such committee members, after ample communication with both the student and the chairper-son, remain on the committee and thus prevent the nomina-tion of a committee that might eventually accept what could be unsatisfactory work. Such a committee member could agree that a dissertation is ready for defense but should not be passed (or should not be passed without substantial modifica-tion). There will, of course, be situations in which the member-ship of research committees should or must be changed (e.g., turnover of faculty), but changes because of modifications in the dissertation topic or some equally plausible reason should be made early in the writing of the dissertation.

Thirty days prior to the scheduled defense of the dissertation, the candidate must submit to the University Graduate School a defense announcement via the electronic document (e-doc) system. (Some programs may have requirements which are earlier than those of the University Graduate School; therefore, students should consult with their program office.) The announcement contains, among other things, a summary of the dissertation (not less than 150 words) which is informa-tive and contains a brief statement of the principal results and conclusions. The announcement must be approved by the research committee chairperson. If the candidate has published any scholarly articles relevant to the topic of the dissertation, bibliographical references should be included in the summary. A copy of such announcements will be sent to any member of the graduate faculty upon request.

Once the final examination has been scheduled, the announced time and place of the defense must not be changed without the approval of the dean. Any member of the graduate faculty who wishes to attend the final examination is encouraged to do so; it is requested, however, that the faculty member notify the chairperson of the research committee in advance so that space can be arranged. With the approval of the research committee and the consent of the candidate, other graduate students may attend the defense of the dissertation; normally such students will act as observers, not as participants.

At the end of the oral examination, the research committee must vote on the outcome of the examination. Four options are available to the committee: (1) pass, (2) conditional pass, (3) deferred decision, and (4) failure. If the decision to pass is unanimous, the dissertation is approved once it is
received by the University Graduate School along with an acceptance page signed by the members of the research committee. If the decision is not unanimous, majority and minority reports should be submitted to the dean who, within 10 working days, will investigate and consult with the research committee. Upon completion of the dean’s investigation and consultation, another meeting of the research committee will be held, and if a majority votes to pass, the dissertation is approved when it is received by the University Graduate School with an acceptance page signed by a majority of the members of the research committee.

The student must have received acceptance of his or her dissertation and must submit a copy to the University Graduate School within seven years after passing the qualifying examination. Failure to meet this requirement will result in the termination of candidacy and of the student’s enrollment in the degree program. Any student whose candidacy lapses will be required to apply to the University Graduate School for reinstatement before further work toward the degree may be done formally. To be reinstated to candidacy in the University Graduate School, the student must: (1) obtain the permission of the departmental chairperson; (2) fulfill the departmental requirements in effect at the time of the application for reinstatement; (3) pass the current Ph.D. qualifying examination or its equivalent (A department must define in advance specifically what is meant if an “equivalent” examination is to be used, and that definition must be approved by the dean.); and (4) request reinstatement to candidacy from the dean. Such reinstatement, if granted, will be valid for a period of three years, during which time the candidate must enroll each semester for a minimum of one credit.

Submission of the Dissertation
Following acceptance by the research committee, the dissertation is submitted to the University Graduate School. Students are expected to submit the final version of the dissertation within six months of the defense date to maintain sufficient academic progress. For complete guideline information, see the University Graduate School’s website (www.graduate.indiana.edu) section related to Thesis & Dissertations.

Each dissertation must include a title page bearing the statement: “Submitted to the faculty of the University Graduate School in partial fulfillment of the requirements for the degree Doctor of Philosophy in the Department of Intelligent Systems Engineering, Indiana University.” (Note: Students majoring in programs will use "Program of;" students majoring in departments outside of the College of Arts and Sciences will use "School of.") The date of this page should be the month and year when all requirements have been satisfied; this is not necessarily the month in which you defend. Following the title page is the acceptance page with the statement: “Accepted by the faculty of the University Graduate School, Indiana University, in partial fulfillment of the requirements for the degree Doctor of Philosophy.” The acceptance page must be signed by members of the research committee. See the online guide for the complete order for the front matter.

The candidate must also submit an abstract of no more than 350 words for the dissertation that has been approved and signed by the research committee. The abstract will appear in ProQuest Dissertations & Thesis Database, managed by ProQuest Dissertation Publishing, Ann Arbor, Michigan. If the original abstract is not in English and an English translation has been made, submit both the English and non-English language abstracts.

Any creative work, such as a dissertation, is automatically copyrighted; however, registration with the U.S. Copyright Office provides (various/certain) legal benefits. The cost for registering a work through ProQuest is currently $55. Contact the University Graduate School for details.
Electronic Submission: This is the preferred submission method. Once approved and finalized, the dissertation should be submitted electronically in the form of a .pdf file to ProQuest. A microfilm version will also be made available for purchase from ProQuest Dissertation Publishing by all those who request it. Effective September 27, 2010, there is no longer a fee for those dissertations submitted electronically and opting for Traditional Publishing. Open Access publishing has a fee of $160.00

Traditional Unbound Paper Submission: If the student wishes to submit via traditional unbound paper method, he or she must schedule a dissertation review appointment with the PhD recorder in the University Graduate School, once his/her research committee has approved the final version of the dissertation. In this appointment, the recorder will review an unbound copy of the dissertation for necessary formatting revisions. The student will need to make the requested revisions and submit to the University Graduate School one unbound copy of the dissertation for necessary formatting revisions. The student will need to make the requested revisions and submit to the University Graduate School one unbound copy of the dissertation, in a box suitable for mailing, and one bound copy. The bound copy is sent to the University Library. Some departments also require an additional bound copy. Students should contact their department regarding departmental policies on bound copy submission. The unbound copy will be submitted to ProQuest where the abstract will be published and the dissertation microfilmed for storage in their database. The required fee for publishing the abstract and microfilming the dissertation is currently $65 for traditional publishing or $160 for Open Access Publishing.