

University of Virginia
Department of Systems and Information Engineering

DOCTOR OF PHILOSOPHY HANDBOOK

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1. PROGRAM DESCRIPTION

1.1 DOCTOR OF PHILOSOPHY (Ph.D.) is an advanced graduate degree for those wishing to contribute to knowledge through independent, original research at the cutting edge of systems engineering. The program provides a springboard for careers as academicians, researchers, consultants, and higher-level engineering managers in universities, institutes, industry, and government.

1.2 Doctoral students should possess initiative, inquisitiveness, ingenuity, and perseverance. Our program affords each student the flexibility to design a plan of study that fulfills the individual's career objectives and intellectual aspirations. The primary concern of the faculty is to give each student guidance to and opportunity for a complete educational experience and superior professional preparation. Towards that end, the program includes four components.

- ***Courses*** through which the student acquires fundamental and advanced knowledge.
- ***Colloquium***, a regular meeting of graduate students and faculty for presenting and discussing contemporary systems problems and research.
- ***Research*** conducted individually, under the guidance of an advisory committee, and leading to a doctoral dissertation and scholarly papers.
- ***Participation*** in the intellectual life of the University.

2. DEGREE REQUIREMENTS

2.1 School of Engineering and Applied Science Degree Requirements. The program must include a combined minimum of 72 credits of research and graduate level course work *beyond the baccalaureate*. The program must also include a minimum of 24 credits of formal course work. Classes at the 4000-level or below do not count toward the graduate degree requirements. Transfer of course credit from other schools of recognized standing may be included in the program of study; however, only courses with a grade of B or better may be transferred. The student and advisor will work on a course plan for approval by their committee and department graduate director.

2.2 Systems Engineering Requirements. A candidate for the Ph.D. degree must fulfill the general requirements of the School of Engineering and Applied Science listed above and the following specific requirements.

- **Complete an approved plan of study** consisting of at least 12 credit hours of courses, 2 credit hours of colloquium, and 24-34 credit hours of research* – all credit hours beyond the baccalaureate degree.
* Research credit hours apply to the 72 credit SEAS requirement listed above.
- **Pass a comprehensive examination.**
- **Present satisfactorily a dissertation proposal.**
- **Present at least one colloquium.**
- **Publish, or have under review,** at least one scholarly paper in an archival journal, *and* publish at least one paper in conference proceedings.
- **Defend satisfactorily a dissertation.**

2.3 The nominal sequencing and timing of the doctoral program requirements is as follows:

Year 1

1. Identify a RESEARCH AREA.
2. Establish a WORKING RELATIONSHIP with the faculty advisor.
3. Form an ADVISORY COMMITTEE.
4. Develop and submit a PLAN OF STUDY.

Year 2

1. Finish taking COURSES.
2. Take COMPREHENSIVE EXAMINATION.
3. Develop a PLAN OF RESEARCH.
4. Present DISSERTATION PROPOSAL.
5. Petition for ADMISSION TO CANDIDACY.

Year 3

1. Present COLLOQUIUM.
2. Submit a paper for PUBLICATION.
3. Defend DISSERTATION.

2.4 The student must complete all the requirements for the Ph.D. degree within seven years after admission to the doctoral program. Expired credits may be revalidated upon approval of the faculty advisor, the departmental graduate programs committee, the SEAS graduate studies committee, and the Office of the Dean.

3. ADVISORY COMMITTEE

3.1 Upon admission to the program, the student is assigned a faculty advisor. The student should meet with the advisor to initiate a planning effort. [Once the student identifies a research area, the faculty advisor may be changed.]

3.2 As soon as the student identifies the research area, an advisory committee should be proposed to the Graduate Programs Director, who approves it and recommends it for appointment to the Office of the Dean. The advisory committee must consist of at least 4 members of the University faculty: 2 members representing the major area of study, and 2 members each representing one minor area of study. At least 3 members must have their primary appointments (not joint appointments) in the Systems and Information Engineering Department. At least one member must be from outside the department.

3.3 The advisory committee meets with the student as soon as possible to assist in planning study and research. The committee recommends formal courses to be taken, discusses with the student research objectives and the plan of research, and advises the student on the areas which must be covered by the comprehensive examination.

3.4 The advisory committee meets with the student as needed to review progress and, if necessary, to assist the student in revising the plan of study or the plan of research.

4. SIE Ph.D. CURRICULUM

Any student enrolled in the Ph.D. program prior to the fall 2016 semester has the option of adhering to either (a) the curriculum presented below or (b) the curriculum that was effective when the student first enrolled in the Ph.D. program.

Mandatory Courses

SYS 6001 – Introduction to Systems Analysis and Design (1 course)

SYS 7096 – Systems Engineering Colloquium (2 semesters as SIE Ph.D. student)

Foundations (3 courses selected from the following)

SYS 60XX – Autonomy and Controls I

SYS 6007 – Human Factors I

SYS 6003 – Optimization Models and Methods I

SYS 6005 – Stochastic Modeling I

SYS 6021 – Statistical Modeling I

Methodological Areas (5 courses from at least 2 areas)

Certain courses are listed in multiple areas. In cases where a course is listed in multiple areas, the student must decide which area the course satisfies for the student's plan of study. Each course may only satisfy one area for the student's plan of study. Other appropriate courses – as approved by the graduate committee in advance of registration – may be substituted into these areas.

Autonomy and Controls

APMA 6548 – Introduction to Chaos, Bifurcation, and Stability
ECE 7856 – Nonlinear Control Systems
ECE 8825 – Adaptive Control
SYS 60XX – Autonomous Mobile Robotics
SYS 60XX – Collaborative Autonomy
SYS 60XX – Reinforcement Learning
SYS 6014 – Stochastic Control and Decision Analysis
SYS 7005 – Stochastic Processes, Autonomy, and Controls

Human Factors

SYS 6036 – Design of Experiments
SYS 60XX – Human Factors Design for Community Health
SYS 6024 – User Experience Design
SYS 6023 – Cognitive Engineering
SYS 6026 – Quantitative Models of Human Perceptual Information Processing
SYS 6064 – Applied Human Factors Engineering

Optimization

SYS 6042 – Network and Combinatorial Optimization
SYS 7063 – Simulation Optimization

Decision and Risk Analysis

SYS 6014 – Stochastic Control and Decision Analysis
SYS 6034 – Discrete-Event Stochastic Simulation
SYS 6035 – Agent-Based Modeling and Simulation
SYS 6041 – Ethics in Engineering Research and Practice
SYS 6050 – Risk Analysis
SYS 6070 – Environmental Systems Processes
SYS 7001 – Systems and Decision Science
SYS 7005 – Stochastic Processes, Autonomy, and Controls
SYS 7075 – Bayesian Forecast-Decision Theory

Statistical Modeling

STAT 5170 – Applied Time Series
STAT 6440 – Introduction to Bayesian Methods
SYS 6016 – Machine Learning
SYS 6018 – Data Mining

Research Electives (3 courses)

Courses at the 6000 and 7000 levels are chosen in consultation with the advisory committee to support the student's research program.

Receiving Credit for Prior Graduate Coursework

Prior graduate coursework may be used to fulfill the above requirements. For example, if a student believes that he or she has previously passed a graduate course equivalent to SYS 6018 – Data Mining (at UVa or any other institution), then this student may petition to use this previous course to fulfill the Statistical Modeling area. The petition process is described in the Petition Form (https://docs.google.com/document/d/1o1rElwZP6ARSOfrUjMo1_2NMnAvdAp-qMMZ11EsRPyw). In all cases at least 4 courses must be taken within the SIE graduate offerings, with the restriction that independent study courses and courses originating in other departments and cross-listed with SIE are not eligible.

5.0 PLAN OF STUDY

5.1 Immediately upon entering the program, the student should engage in a thorough and intensive planning effort in order to

- (i) crystallize academic and career objectives,
- (ii) identify a research area, and
- (iii) establish a working relationship with the faculty advisor, and with the faculty members who agree to serve on the advisory committee.

This planning effort culminates in a plan of study. The student should complete an approved plan of study consistent with the SIE Ph.D. Curriculum defined above.

5.2 The plan of study must be submitted to the advisory committee for approval no later than the end of the second semester of doctoral study. Then it must be approved by the Graduate Programs Director.

5.3 The approved plan of study may be revised if necessary; the new plan must be submitted promptly for approval.

5.4 A student completing a master's degree in systems engineering at the University of Virginia and wishing to enter the doctoral program should request admission before submitting the plan of study.

5.5 When preparing the plan of study, the student should seek a balance between the breadth of fundamental knowledge and the depth of advanced knowledge. The following conditions apply.

- **Courses.** All courses beyond the bachelor's degree must be included in the plan of study.

- **Transfer Credit.** Courses transferred from other institutions of recognized standing must be included in the plan of study. The request for credit transfer must be submitted separately and must include the following documents: a description of course content and level, an official transcript, and a statement by the student certifying that the course has not been used to satisfy requirements for another degree. If the student is already admitted into a program at the University of Virginia, then the request for credit transfer must be pre-approved before the course is taken.
- **Colloquium.** At least 2 credit hours of systems engineering colloquium, SYS 7096, beyond the master's degree. The colloquium is a regular meeting of graduate students and faculty for presenting and discussing contemporary systems problems and research. Each doctoral student must present at least one colloquium prior to defending the dissertation.
- **Research.** At least 24 credit hours of research towards dissertation, SYS 9999. The research is performed under the direction of the faculty advisor and the advisory committee, and is documented in a written dissertation.

5.6 Besides working to complete the plan of study, the student should exploit the vast opportunities for intellectual enrichment that the University offers. In particular, the student is expected to actively participate in various colloquia, defenses of master's theses, presentations of doctoral dissertation proposals, and defenses of doctoral dissertations. Being an active member of the academic community and a contributor to its intellectual life is viewed by the faculty as an essential prerequisite for admission to candidacy for the doctor's degree.

6. COMPREHENSIVE EXAMINATION

6.1 The student should take the comprehensive examination within 18 months of starting the doctoral program.

6.2 The comprehensive examination requires the student to demonstrate

- (i) mastery of materials from the courses prerequisite for the Ph.D. degree,
- (ii) a deep understanding of a body of advanced knowledge,
- (iii) a degree of sophistication in analyzing and synthesizing this knowledge, and
- (iv) superior communication skills.

The examination covers a broad spectrum of subjects within the student's major and minor areas of study. These areas are proposed by the student in harmony with the plan of study and must be approved by the advisory committee. The major area should constitute a subset of systems engineering (systems analysis, design, and integration; decision theory and risk analysis; optimization and control; forecasting and simulation; human factors) and should include the fundamentals of systems engineering covered in one of the methodological courses. Two minor areas may fall within or without systems engineering (e.g., within civil engineering, computer engineering, environmental sciences, mathematics, statistics, economics, cognitive psychology).

6.3 The examination consists of two parts, written and oral, and must be passed as a whole. The following guidelines apply.

- The examining committee must include the student's advisory committee, and may also include additional members. The request to appoint the examining committee must be submitted at least 14 days before the proposed start of the examination. The request must be approved by the Graduate Programs Director and by the Office of the Dean.
- The student proposes a list of readings organized by topics and subtopics in the major and minor areas. The list must be approved by the advisory committee.
- The student proposes the examination schedule. Each member of the examining committee prepares written questions related to the list of readings. The student has 10 days to answer in writing the questions. The oral examination takes place within one week of returning the answers.
- The test of satisfactory performance is whether in the professional judgment of the examining committee the student has demonstrated advanced knowledge and expert qualifications to such a degree that the faculty members are, or soon will be, willing to accept the student as a junior professional colleague. Feedback is given to the student at the end of the oral examination. A student who does not give a satisfactory performance may be allowed, upon the recommendation of the examining committee, to retake the examination within 6 months. The examination cannot be retaken more than once.

7. DISSERTATION PROPOSAL

7.1 A written dissertation proposal must be submitted to the advisory committee, and then presented orally in a public examination. This examination should take place no later than 12 months following the comprehensive examination.

7.2 The proposal should state the research objectives, assess the state of the art, outline the proposed method of investigation, and discuss the anticipated results and their significance. The document should not exceed 20 pages, double-spaced.

7.3 The examination of the dissertation proposal should be planned and conducted in accordance with the following guidelines.

- The examining committee must include the student's advisory committee, and may also include additional members. The request to appoint the examining committee must be submitted at least 14 days before the proposed examination date. The request must be approved by the Graduate Programs Director and by the Office of the Dean.
- The examination should be scheduled when the University is in regular session, i.e., between the first and last day of classes. The last dates are: December 1 in Fall semester, May 1 in Spring semester, and August 1 in Summer session.
- At least 2 hours must be allotted for the examination.
- The announcement of the examination to all SEAS faculty and SIE graduate students must be submitted to the department at least 14 days prior to the examination.
- A copy of the dissertation proposal must be available for reading in the department's office at least 14 days prior to the examination.
- The student should prepare an oral presentation of the proposed research lasting about 30 minutes.
- A student who does not give a satisfactory performance on the examination may, upon the recommendation of the examining committee, be granted a further examination.

8. ADMISSION TO CANDIDACY

8.1 Admission to candidacy occurs after the student has met the following requirements.

- Completed courses listed on the approved plan of study and met the minimum grade requirements of the School of Engineering and Applied Science.
- Passed the comprehensive examination.
- Received approval for the dissertation proposal.

8.2 Admission to candidacy must be completed at least one semester before the defense of the dissertation.

9. DISSERTATION

9.1 The doctoral dissertation should document an independent, original research that makes a significant contribution to a field of research within systems engineering.

9.2 The dissertation should be prepared in accordance with the instructions from the advisory committee.

9.3 The dissertation must be submitted to the examining committee at least 21 days prior to the defense.

10. DISSERTATION DEFENSE

10.1 The final examination consists of an oral presentation and defense of the dissertation in a public forum. It is designed to assess the student's contribution to a field of research and to test the student's knowledge of that field.

10.2 The final examination can be offered only after the student has submitted the dissertation to the examining committee with sufficient lead time and has met all other degree requirements. It should be planned and conducted in accordance with the following guidelines.

- The examining committee must be composed of at least 5 members, and must include the student's advisory committee. The request to appoint the examining committee must be submitted to the department at least 21 days prior to the examination date. The request must be approved by the Graduate Programs Director and by the Office of the Dean.
- The examination should be scheduled when the University is in regular session, and enough time remains for dissertation submission. The last dates are: November 15 in Fall semester, April 15 in Spring semester, and July 15 in Summer session.
- At least 2 hours must be allotted for the examination.
- The announcement of the examination to all SEAS faculty and SIE graduate students must be submitted to the department at least 14 days prior to the examination.
- A copy of the dissertation must be available for reading in the department's office at least 14 days prior to the examination.
- The student should prepare an oral presentation of the research lasting about 40 minutes.
- A student who does not give a satisfactory performance on the examination may, upon the recommendation of the examining committee, be granted a further examination.

11. DISSERTATION SUBMISSION

11.1 After the defense, the student must revise the dissertation in accordance with the report of the examining committee.

11.2 After the final version of the dissertation is approved by the examining committee, the student must secure signatures of the committee members and the Dean on the approval sheet, which then must be scanned and inserted into the dissertation behind the title page.

11.3 The dissertation must be submitted electronically to Libra Electronic Thesis and Dissertation (ETD) repository by the date specified by the Office of the Dean.

12. APPLICATION FOR THE DEGREE

12.1 An application for the degree must be submitted in two forms (paper and electronic) by the date specified in the academic calendar. This is usually October 1 for January graduation, February 1 for May graduation, and June 1 for August graduation.

12.2 The student must be registered during the semester in which the application for the degree is submitted.

13. ADMINISTRATIVE FORMS

All forms that must be completed in the course of study may be obtained in Olsson Hall 114, or may be found at

<http://web.sys.virginia.edu/graduate/forms-and-documentation.html>
(departmental forms)

<http://www.seas.virginia.edu/advising/allforms.php>
(school forms)

All administrative requirements that must be met before graduation in the School of Engineering and Applied Science may be found at

http://www.seas.virginia.edu/advising/graduation_procedure_MS_PhD.php

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