



Doctor of Philosophy (PhD) in Systems Engineering:

Policy Manual

March 2020 – rev 2



This policy manual was prepared by the Systems Engineering (SE) Department Doctoral Committee and will be provided to all incoming PhD students and to all Systems Engineering Department faculty members. The manual summarizes the requirements expected for acceptance into and successful completion of a doctoral degree program and the procedures that must be followed by students and faculty. It will be regularly reviewed by the Doctoral Committee and kept up-to-date. An electronic version will be maintained on the department website.

Although every attempt has been made to present the material in the policy manual in a clear and logical order, the Doctoral Committee may not have been completely successful. It is expected that every SE PhD student will read it in its entirety and be familiar with all aspects of the program. Comments for improving the policy manual will be appreciated by everyone and should be forwarded to the SE Department Doctoral Committee Chair.

Lois Hazard, Editor

Points of Contact: Further technical information on the SE Department doctoral degree program may be obtained by contacting:

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Systems Engineering Doctoral Degree Program

The Systems Engineering Department of the Naval Postgraduate School offers study and research leading to the award of the Doctor of Philosophy (PhD) degree in Systems Engineering. The PhD degree involves required coursework, comprehensive qualifying examinations, and a research-based dissertation. The PhD degree may be pursued via resident or hybrid study (distance learning plus periodic temporary residence).

Resident students may complete their dissertation research at another site after completing coursework at an NPS location. However, some travel to Monterey (for an initial orientation visit, qualifying exams, and dissertation defense) is required even if students are resident at another NPS location.

In the dissertation writing phase, students should expect to spend one week per quarter at NPS in Monterey, or the location of the student's dissertation supervisor, in order to conduct research while working directly with their dissertation supervisor. Though this is not a requirement, it is highly recommended for successful completion of the PhD degree.

While applications are accepted throughout the year, doctoral study beginning in any academic quarter, we expect to have two starts per year for PhD students beginning in the fall and the spring quarters. The quarter of entry will affect the order in which required courses may be taken (most are offered only once per year) but will have no impact on the total duration or difficulty of the program.

Systems Engineering Course Requirements

All students are required to take a minimum of six of the courses from the SE curriculum listed below. Required courses are at the 4000 level. Students are also required to take a research methods course (SE3077 Research Methods in Systems Engineering)¹ which does not count toward the minimum of six courses. Several of the courses below have prerequisites, which would require that any student who has not taken those prerequisites obtain a waiver from the course instructor or take the prerequisite course. Students may substitute one of these required courses with another course from outside of the SE curriculum with the approval of his/her dissertation chair:

- SE4910 System Dynamics and Control
- SE4920 Reverse Engineering of Systems and Subsystems
- SE4930 Model-Based Systems Engineering
- SE4935 Formal Methods for System Architecting
- SE4940 Engineering of Complex Systems
- SE4950 Systems of Systems Engineering
- SE4960 Network Concepts in Systems Engineering
- SE4980 Enterprise Systems Engineering
- OA4302 Reliability and Weapons System Effectiveness Measurement
- SE4321 Reliability Growth and Accelerated Testing
- SE4900 Directed Study

In addition to these six required courses, other advanced courses may be taken by the student at the discretion of his/her dissertation chair. The following courses represent required knowledge for qualifying exams but are not counted toward PhD course requirements:

- OS 3180 Probability and Statistics for Systems Engineering
- SE 3100 Fundamentals of SE
- SE 3302 System Suitability
- SI 3400 Project Management

Following completion of coursework, the student is expected to enroll in at least one section per quarter of SE5900 Doctoral Research Initiation until advanced to candidacy. After advancement to candidacy, the student is expected to enroll in at least one course section quarter of SE5810 Dissertation Research. Pursuit of additional elective courses during the research phase of the doctoral program is encouraged at the discretion of the student's dissertation committee chair.

Transfer of Course Credits

Acceptance of the transfer of course credits from other institutions is per the discretion of the Academic Associate.

Sequence of Events Leading to a PhD Degree

The following is the typical sequence of events leading to successful award of a Doctor of Philosophy in Systems Engineering degree:

¹ Note: Currently SE3077 is not offered for PhD students. In lieu of taking SE3077, the department is offering an intensive seminar on research methods occasionally. Contact the PhD Program Academic Associate for additional details. – Current as of March 2020.

- Completion of master's level coursework
- Application for admission
- Departmental doctoral committee review and acceptance into program
- Completion of required courses and elective courses
- Completion, with a passing score, of each individual exam that makes up the written qualifying exam
- Form a dissertation committee, led by a dissertation chair
- Doctoral committee nomination of dissertation committee, dissertation chair, and approval by Academic Council
- Completion of oral qualifying examination with a passing score
- Preparation of a dissertation proposal and approval of the dissertation topic (may precede completion of oral qualifying examination)
- Doctoral committee recommendation of advancement to candidacy and approval by Academic Council
- Conduct of dissertation research
- Submission of a journal article for publication in a peer-reviewed journal
- Completion of "final draft" of dissertation
- Oral dissertation defense and unanimous approval by dissertation committee
- Completion of publishable dissertation and unanimous approval by dissertation committee
- Dissertation committee nomination for PhD degree and Academic Council approval of award of degree
- Graduation

As is evident from the listing, there is limited flexibility in some parts of this process and zero flexibility in others (typically those involving Academic Council approval).

Admissions

NPS doctoral programs are available to officers and qualified enlisted personnel of all U.S. services, civilian employees of the U.S. government, and to individuals sponsored by selected allied nations. Applications may be submitted at any time. An individual applying for admission to a doctoral program in Systems Engineering must hold a bachelor's degree qualifying the student for graduate status in the department of his/her major study, or shall have completed an equivalent course of study, and must have a master's degree in a related technical field. All U.S. applications shall be submitted to the Director of Admissions, who will be responsible for processing. International applications shall be submitted to the International Graduate Programs Office. All applications are forwarded by the Director of Admissions to the chair of the Systems Engineering Department for determination of acceptability by the departmental doctoral committee. The department chair, through the departmental doctoral committee, will recommend appropriate action to the Director of Admissions, who will notify applicants.

The application must include the following:

- A completed online application form.
- Certified copies of all undergraduate and graduate transcripts. Transcripts from NPS are not necessary, but transcripts from other schools are required of current and former NPS students.
- Results of a Graduate Record Examination (GRE) General Test taken within the past five-years. Applicants with graduate degrees and no GRE results may request a waiver of the GRE from the Admission's Office. Applicants with GRE results older than five years may submit those results along with a proxy letter. The SE Department Doctoral Committee will evaluate such letters to determine if the GRE requirement can be waived.
- A brief letter of intent (200 words or fewer) identifying specific areas of interest within the proposed major field of study. This does not commit the student to those areas.
- At least two letters of recommendation regarding the candidate's academic potential in order to assess his/her ability to conduct graduate level research. These letters should be written by someone who has earned a PhD degree and can adequately assess the candidate's ability to conduct doctoral level research, apply critical thinking, and then write an appropriate dissertation proposal and dissertation. An ideal person would be an instructor or adviser from the candidate's master's program.
- A writing sample solely authored by the candidate to assess his/her writing competency. The writing sample may be from a journal paper, conference paper, or individual report from a graduate level course.
- Attestation by the student's sponsoring agency or nation that they are committed to tuition and salary support during the student's residence at NPS. An additional entry to this attestation should include that the sponsor realizes that the primary deliverable from this effort is an even more valued employee who now has a doctoral degree. This means that the candidate must choose a dissertation topic that advances the body of knowledge of Systems Engineering and may not be directly related to activities of the sponsoring agency.

SE Department Doctoral Committee

The SE doctoral degree program is overseen by an SE Department Doctoral Committee, which approves dissertation committees, performs other program oversight and monitoring tasks as required, and prepares and maintains a Systems Engineering Doctoral Program Policy Manual. The SE Department Doctoral Committee Chair will manage the doctoral program. The Chair (through appropriate actions of the Doctoral Committee) will:

- Oversee the acceptance of students into the doctoral program,

- Monitor the status and progress of students in the doctoral program,
- Provide advice and guidance to the students to facilitate successful completion of the program, and
- Certify the satisfactory completion of all degree requirements.

The SE doctoral degree program has an Academic Associate who is also responsible for ensuring that:

- Students have a well-defined program leading to the desired degree
- Are enrolled in the proper courses in the proper quarter
- Are making acceptable progress toward their degree
- Understand any actions they must take to remediate unacceptable progress

Student Orientation

While there is no formal orientation process for students, we expect newly admitted students to be on campus for two to three days to meet with the Academic Associate to establish a program of study and to meet with the SE faculty. This should occur no later than the first month of beginning the doctoral program.

Qualifying Examinations

A qualifying examination (consisting of both written and oral components) will be administered according to the procedures outlined in the NPS Academic Council Policy Manual. This comprehensive examination will test the student's mastery of the fundamentals and assess readiness to begin dissertation research. The written component of the examination must be taken and passed before the student may attempt the oral component of the examination.

Written qualifying examinations for the Systems Engineering doctoral degree program consist of a total of five exams. These exams are:

- SE Fundamentals: This will include material from SE3100, SE3302, and SI3400.
- Applied Probability and Statistics for Systems Engineers: This will include material from OS3180, SE3250, and SE3302.
- Three exams on 4000 level courses: This will include at least two from the above list of 4000 courses, and a third 4000 level course exam as approved by the dissertation chair.

The oral component of the qualifying examination is the culmination of the course of study. The purpose is to test basic knowledge and creative ability and to demonstrate the student's capacity to use material from the course of study. The oral qualifying examination shall contain no prepared presentations. The format is exclusively question and answer. The oral exam is an attempt to determine if the student is ready to begin dissertation research. However, the oral exam is not a defense of the dissertation proposal. Indeed, the student does not need to have selected a dissertation committee or a dissertation topic before taking the oral exam. If the student does have the potential dissertation topic, the examiners are permitted to ask questions pertinent to the general area of the topic, but are not permitted to ask specific questions about the particular of the proposed topic.

The NPS Academic Council Policy Manual specifies the manner in which the oral qualifying exam is conducted. The steps in the oral examination are:

- The departmental doctoral committee chair (or his/her designee – typically the dissertation chair) introduces the process (ground rules) and participants.
- The examinee is not permitted to make any presentation.
- The departmental doctoral committee members (or their designees – typically the student's dissertation committee members) question the examinee. There is no prescribed limit on the length of the question period. Typically, the committee members will ask questions for roughly 15-20 minutes each. Every member of the examining committee is expected to ask questions. The chair determines the order and time period for each questioner.
- After the committee is finished with its questions, selected others may be allowed to ask questions, subject to approval by the committee chair. If the doctoral committee conducts the examination, members of the departmental doctoral committee may be requested to ask additional questions.
- Examinee, students, staff, and visitors must leave during committee discussions.
- Committee members discuss their observations about examinee.
- The committee votes whether or not the candidate successfully passed the examination. Passage requires unanimous consent of the examiners.
- The chair informs the examinee of the results.
- Within two weeks of the examination the doctoral committee chair sends a written report of the results (signed by all members of the examining committee) to the Academic Council, the Program Officer, and the Vice Provost for Academic Affairs.
- A written report (from the Academic Council rep) of conformance with Academic Council policy goes to the Academic Council.

All members of the departmental doctoral committee (or its formally designated representatives) must attend all aspects of the oral exam. Often the student's dissertation committee is designated to conduct the oral exam. A representative of the Academic Council must be present to ensure that the oral exam is conducted in the proper fashion. The departmental doctoral committee (or its formally designated representatives) must attend the interrogation phase, must participate in the comment phase, and must vote. The Academic Council rep must attend the interrogation phase, may participate in the comment phase (at the discretion of the committee chair), and must attend the voting phase, but may not vote. Other faculty, students, staff, and visitors may attend the interrogation phase (at the discretion of the committee chair). The student must attend the interrogation phase, but may not attend the comment or voting phases. Immediately after voting, the student will be informed of the results.

The oral exam will be scheduled after completion of all required coursework and of being notified of successful completion of the final written component of the exam. The exam is typically scheduled within three months of satisfaction of the above requirements, but there is no limit set by the Academic Council. NOTE: Unless the student has severe difficulties with oral communication, passage of the written examination should presage passage of the oral examination. Students with oral or written communication difficulties should discuss the matter with the Academic Associate as early as possible to determine ways to overcome, eliminate, or ameliorate those difficulties.

Second Attempts

Students who fail either the written or oral components will usually be given the opportunity to take the exam a second time. Upon a student's failure on a first attempt to pass the written exam, the departmental doctoral committee will evaluate the nature of the poor performance, recommend a course of remedial study, and determine the appropriate time for the second attempt. The student will be reexamined only on the part(s) of the written exam that were failed on the first attempt. There will be no reexamination on the parts passed on the first attempt. The second attempt will occur not less than 3 months but no later than 12 months after the first attempt.

Upon a student's failure on a first attempt to pass the oral exam, the dissertation committee will evaluate the nature of the poor performance, recommend a course of remedial study, and determine the appropriate time for the second attempt. There will be no minimum time for the oral re-examination, but it shall occur no later than 12 months after the first attempt. Students passing the written examination on the second attempt will not be barred from consideration for a second attempt on the oral examination. However, no student shall be given a third attempt to take any component of the examination.

Dissertation Proposal

When working through the first few quarters of the SE doctoral degree program, students must balance the need to successfully complete courses, prepare for qualifying exams, and engage faculty in order to explore potential research topics for the dissertation. After successful completion of the course requirements and all oral and written components of the comprehensive examination, full-time work on the dissertation can begin. Students will be required to develop, present, and defend a formal dissertation proposal to their dissertation committee (and possibly to the entire SE faculty) before advancing to candidacy.

The proposal should contain a working title, the membership of the dissertation committee, an abstract suitable for outside dissemination, and sufficient definition of the proposed research program for the committee to assess:

- The significance of the proposed research (Is it worth doing?)
- The validity of the proposed approach (Is the approach likely to yield a successful outcome?)
- The originality of the proposed research (Is it novel?)
- The feasibility of the proposed research (Can it be completed in a reasonable time frame with the available resources?)

This proposal will typically be developed and defended in the quarter following completion of the comprehensive examinations. In all cases, the System Engineering Department desires that the proposal be defended before the end of the second quarter following the exams. The nature of this defense will be determined by the dissertation committee. There is no standard approach or minimum requirement imposed on the proposal defense. The proposal must be successfully defended and approved before the student can be advanced to candidacy.

Dissertation Committee

There is always a chair of a dissertation committee, as well as a dissertation supervisor. The chair provides formal oversight over all matters regarding the dissertation process, to include the oral exam (if conducted by the dissertation committee), defense, and final approval of the dissertation. The dissertation supervisor serves as the primary research adviser to the student, providing frequent guidance and direction regarding the dissertation contribution and development. To be the chair, an SE faculty member must have served as a committee member on a completed dissertation. The chair generally serves a dual role as both chair and dissertation supervisor; however, one of the other dissertation committee members may serve as the supervisor, at the discretion of the chair, and must be from the Systems Engineering Department.

At least three members (including the chair) must be faculty members with primary appointments in the Systems Engineering Department, and with PhDs, and at least one must have tenure. At least one member must be chosen from another department at NPS, must have a PhD, and will be selected for his/her expertise in an area related to the dissertation research. The fifth (and/or sixth)

member may be a PhD or non-PhD faculty member in any NPS department, or may be a qualified individual associated with an external organization.

Doctoral Dissertation Research

The character and conduct of research for every dissertation are likely to be unique to the student, the membership of the doctoral committee, and the topic of the dissertation. The research phase of the doctoral program will involve:

- Extensive self study of prior work in both the discipline and domain associated with the project. The student should expect to read an extensive number of books and journal articles to master the prior work. Extensive reference should be made to all of the relevant prior work.
- Independent and original contribution to the field. The dissertation is the student's work (not the supervisor's), and the student's contributions (vice the supervisor's) should be obvious to any reader of the dissertation.
- Conceptually complete, contextually relevant, and thoroughly defensible results and conclusions. The student will be required to publicly defend the dissertation against all challengers.

The average time required for full-time students at major universities to complete engineering dissertations is between 4 and 5 years. Most full-time military and government students who are sent to Monterey by their sponsors have only 3 years to complete their dissertations. Such students must find a topic and begin to work as soon as possible. It is expected that part-time students will take longer than full-time students. There is also a 5-year limit imposed by NPS on completion of the dissertation. However, the dissertation research will take whatever period of time is required for completion. The student's dissertation committee will not approve an incomplete or inadequate dissertation simply because a sponsor deadline for completion or the end of the 5-year window is approaching.

Changing Dissertation Topics and/or Committees

Such situations are rare but do occasionally arise. A student is not required to stick with a dissertation project after it is determined to have a low probability of success. The student should first discuss any concerns with his/her dissertation committee or with the SE Department Doctoral Committee (if the problem lies with the dissertation committee). In the case that it is agreed that the project is unlikely to succeed, then all affected parties should be notified of this decision. The student should then find another dissertation topic and/or another dissertation committee as soon as possible. After advancement to candidacy, the 5-year clock is running and continues to run even if the dissertation research is altered. All changes to a dissertation committee must be approved by the SE Department Doctoral Committee and by the Academic Council. If the student elects to pursue a substantially different dissertation topic, then a new dissertation proposal must be prepared, defended, and approved before the student may proceed to conducting the new research.

Publication Requirement

All PhD students will be required to prepare and submit as lead author at least one article describing the results of their dissertation research for publication in a peer-reviewed journal. Articles with the student as secondary author or describing work not directly related to his/her dissertation research will not count toward this requirement. This article must be approved by the student's dissertation committee and formally submitted to the journal before the SE Department will recommend them for award of the PhD degree. The article does not need to be accepted for publication by the journal prior to the student's receiving the PhD degree. Subsequent rejection by the journal will not negate the award of the degree. NOTE: Publications must be consistent with any release limitations imposed by sponsoring agencies and must not violate export control regulations.

Dissertation Defense

Upon completion of the dissertation the student will be required to defend that dissertation before his/her complete dissertation committee at NPS. The purpose of the dissertation defense is to determine if the contributions of the dissertation research are sufficient for award of a PhD. A minimum of six months must elapse between successful completion of the oral qualifying examination and the defense of the dissertation. The student provides each member of his/her dissertation committee with a copy of the final draft of the dissertation for review at least two weeks before the dissertation defense. Upon the dissertation committee's unanimous acceptance of the draft dissertation as the basis for a dissertation defense, the dissertation chair notifies the departmental doctoral committee and provides it with a draft of the dissertation. The dissertation chair schedules the final dissertation defense. This examination must be scheduled no later than one week after the submission of the draft of the dissertation to the departmental doctoral committee.

All dissertation committee members must participate in all phases of the final defense. It is acceptable for any dissertation committee member to participate in the defense via video teleconferencing. An Academic Council representative must attend the final defense. Except for classified dissertations, the public will be invited to dissertation defenses.

Passage of the final defense requires unanimous vote of the dissertation committee. If a candidate, on first attempt, fails the final dissertation defense, then the candidate may be re-examined only once, and then only if the dissertation committee so recommends. If the privilege of re-examination is granted, the time period within which it must be accomplished shall be specified by the dissertation committee, but it shall not exceed 12 months.

The NPS Academic Council Policy Manual specifies the manner in which the dissertation defense is conducted. The steps in the formal defense are:

- The dissertation committee chair introduces the process and participants
- The examinee presents the dissertation (nominal 30 to 60-minute presentation)
- Dissertation committee members question the examinee
- After the committee is finished with their questions, others are allowed to ask questions, subject to approval by the committee chair
- Examinee, students, staff, and visitors must leave during committee discussions
- Dissertation committee members discuss their observations about examinee
- The dissertation committee votes whether the defense is successful or not
- The dissertation committee chair informs the examinee of the results
- The dissertation committee chair sends a written report of the results (signed by all members of the committee) to the Academic Council
- A written report (from the Academic Council rep) of conformance with Academic Council policy goes to the Academic Council.

Completion of the Doctoral Program

Upon successful completion of the dissertation defense and obtaining all necessary approvals of the dissertation proper, the student will be recommended to the Academic Council for approval of the award of the PhD degree in Systems Engineering. All requirements for completing the PhD degree must be completed within a period of five years after advancement to candidacy.

The Academic Council votes to approve (or disapprove – this virtually never happens if the departmental doctoral committee has made sure that all prior approvals have been obtained) a recommendation for the PhD degree. If the Academic Council recommends that the president of NPS confer the degree, the student is eligible to participate in a graduation ceremony at which he/she will be formally presented with the doctoral hood of the academic regalia by the dissertation supervisor, and a formal citation of the dissertation research will be read to the audience by the provost. The student’s family may attend the graduation ceremony.

Thoughts on Successfully Navigating the Doctoral Dissertation Process

There are usually several milestones in research: statement of the problem, review of prior work, development of theory and hypotheses, experiments, analyses, and conclusions. Each may form a major section of the dissertation, and each can and should be written (in draft form) as soon as that milestone has been completed. The dissertation committee should be permitted to review each section as soon as it is written (even if it is not in the formal thesis format). Their comments are usually helpful and often guide the direction of the research. This is especially true when one or more aspects of the research have not been adequately addressed.

When the dissertation research has been completed, the PhD candidate prepares a draft of the dissertation and provides a copy to each member of the dissertation committee for approval. Dissertations cannot be read overnight. The student should allow at least two weeks (preferably a month) for review and approval before any necessary milestone must be met. It is wise to remember that all comments and inputs from every member must be seriously considered and addressed in the final document. All members of the dissertation committee must sign the completed dissertation. Given that members of the dissertation committee may be widely distributed geographically and have independent teaching, service, travel, and leave schedules, it is often challenging to arrange meetings (including the dissertation defense), conduct necessary reviews, or obtain signatures from all members in even a reasonably lengthy time period.

After a successful dissertation defense, the draft may require revision. The candidate prepares a final draft of the dissertation and submits it for final approval. This must be accomplished at least two weeks before the Academic Council is scheduled to meet. The student may formally graduate at the ceremony immediately following Academic Council approval. If the Academic Council does not approve recommending the candidate to the president, the student will not graduate at that ceremony.