



John R. and Jeannette Dachille McWhirter Graduate Program

HANDBOOK FOR GRADUATE STUDENTS

Chemical Engineering graduate studies at Penn State are designed to meet the divergent needs of students involved in a variety of research projects in the department. The course requirements are kept to a minimum and the students are given a wide range of choices in developing their own programs of study. To facilitate this process, this handbook describes opportunities and responsibilities related to graduate study in the John R. and Jeannette Dachille McWhirter Graduate Program of the Department of Chemical Engineering. Additional regulations are to be found in the [Graduate Bulletin](#).

Advising for all entering students is initially provided by the Associate Head for the McWhirter Graduate Program (currently, **Dr. Seong Kim**). Students entering the department with a MS degree obtained at other institutions may request their courses to be evaluated as to their equivalence to Penn State courses. Once the thesis topics are chosen by the students, all advising will be done by the thesis advisors.

In designing their programs of study, students should pay attention to the general requirements of teaching, participation in the departmental seminars, graduate student colloquium, and English competency. Also, students should plan in a timely manner the Qualifying Examination (which also satisfies the University's requirement for the English Competency Test), the Comprehensive Examination for the Doctoral Degree and the Oral Doctoral Dissertation Defense, all of which must be officially scheduled by the department.

A set of policies described in this handbook are those currently in force. These are established to ensure that all students achieve the satisfactory level of competency required for a graduate degree in Chemical Engineering while at the same time providing sufficient flexibility to allow students to pursue their individual professional development. They are subject to changes as the chemical engineering discipline and hence our graduate program continues to evolve. The student must make sure that he/she satisfies all the requirements that are in force at the time of his/her admission to the McWhirter Graduate Program at Penn State. Students may consult with the staff person in charge of departmental graduate records (**Cathy Krause**) for any questions related to this handbook of program requirements.

Occasionally unusual circumstances will develop that were not anticipated and may thus not be effectively handled by the written program requirements. If such conditions arise, students should contact the Graduate Program Coordinator and / or the Department Head (**Dr. Phillip Savage**) to discuss the situation and to explore potential options / solutions.

Updated in January 2021

Table of Contents

| | |
|---|----|
| Information on Registration and Tuition | 2 |
| Quick Summary for Non-Thesis MS Students | 3 |
| Quick Summary for Ph.D. Students | 4 |
| APPOINTMENTS | 6 |
| GENERAL REQUIREMENTS | 7 |
| TEACHING REQUIREMENT FOR Ph.D. DEGREES | 7 |
| Teaching Fellow Program | 8 |
| CHEMICAL ENGINEERING COLLOQUIUM (ChE 590, Fall Semester) | 8 |
| CHEMICAL ENGINEERING COLLOQUIUM (ChE 590, Spring Semester) | 8 |
| DEPARTMENT SEMINARS | 9 |
| LABORATORY SAFETY | 9 |
| THESIS INFORMATION | 9 |
| SELECTION OF A THESIS RESEARCH TOPIC | 9 |
| LEAVING BEFORE COMPLETION OF A THESIS | 11 |
| CHANGING FROM PHD TO MS | 11 |
| IMPORTANT TIMELINE | 11 |
| GRADUATE COURSE OFFERINGS | 12 |
| CONTINUOUS REGISTRATION REQUIREMENT | 13 |
| ADVANCING FROM NON-THESIS M.S. TO PH.D. PROGRAM | 14 |
| PH.D. DEGREE REQUIREMENTS | 14 |
| American English Oral Communicative Proficiency Test for International Students | 15 |
| PH.D. QUALIFYING EXAMINATION | 16 |
| English Competency Evaluation through Ph.D. Qualifying Exam | 18 |
| Graduate Minors | 19 |
| APPOINTMENT OF DOCTORAL COMMITTEE | 19 |
| PH.D. COMPREHENSIVE EXAMINATION | 20 |
| AWARDS | 22 |
| EXTERNAL INTERNSHIP | 22 |
| PH.D. DISSERTATION DEFENSE | 22 |
| Thesis and Dissertation Information | 24 |
| NON-THESIS MS DEGREE IN CHEMICAL ENGINEERING | 25 |
| STUDENT ORGANIZATIONS | 28 |
| APPENDIX | 29 |

Information on Registration and Tuition

REGISTRATION:

The University publishes the Semester Schedule of Classes. It is available on-line at [LionPath](#). Students are responsible for their registration through [LionPath](#) every semester following the timetable posted on [University Registrar](#). This process will generate a semester tuition bill (see below). All courses must be approved by the student's thesis advisor (or by the McWhirter Graduate Program Coordinator during the first semester).

The minimum credits required to maintain the full-time student status are 9 for Fall and Spring; in the semester taking less than 9 credits of courses, the PhD student should add ChE 600 to make the total credit to 9 until he/she passes the comprehensive exam (typically the second-year summer). For the student under the graduate assistantship appointment, the maximum credits that can be registered in Fall or Spring is 12; if taking more than 12 credits in a semester requires special permission from the graduate school. The PhD student also is required to register for 1 credit for the summer semester in which the comprehensive exam is taken. *After passing the comprehensive exam, the PhD student should register for ChE 601 with zero credit until he/she finishes the final oral defense. In the semester of taking the oral defense, the student should register for 1 credit again.*

LATE REGISTRATION:

All graduate students who register late will be responsible for payment of all late fees incurred.

TUITION BILL: "Who must file?"

A semester tuition bill will be generated automatically when students register via [LionPath](#). Other fees (except the ones included in the tuition bill) are students' responsibility.

DEPARTMENTAL OBLIGATION

As a Graduate Assistant, *student's first commitment is to do research in the McWhirter Graduate Program in Chemical Engineering*. If a student is going to be employed by any other department, project, or program, the student must inform his/her advisor and the Administrative Manager in Chemical Engineering (**Laurinda Benner**) and get approval from the Chemical Engineering department before the student is appointed. Failure to comply with this procedure could result in the termination of the Graduate Assistantship. Information pertaining to other employment is addressed in the terms of offer.

For international students, there are additional regulations set by the [Directorate of International Student and Scholar Advising \(DISSA\)](#); working without proper permission is a violation of status and a deportable offense.

Quick Summary for Non-Thesis MS Students

- 1) Complete 30 credits of graduate work, including:
 - a) 9 credits of core graduate Chemical Engineering foundational courses, specifically
 - ChE 524 Chemical Engineering Application of Thermodynamics (3 credits)
 - ChE 535 Chemical Reaction Engineering (3 credits)
 - ChE 544 General Transport Phenomena (3 credits)
 - b) 6 credits of ChE coursework at the 500-level (typically 2 elective courses, each 3 credits). In semesters in which offerings of ChE 500-level electives are not sufficient, a list of 500-level graduate courses from outside ChE that may satisfy this requirement will be distributed.
 - c) 6 additional credits of ChE or other elective courses. 3 credits may be at the 400-level or 800-level if the course is aligned with student's future career development. Note that the 400-level credits cannot be from the core courses required of ChE undergraduate majors in the department.
 - d) 2 credits of graduate colloquium (ChE 590). In the Fall Colloquium (1 credit), faculty present their research and the advisor selection process is conducted; also, "[Scholarship and Research Integrity](#)" (SARI) requirements are completed in the Fall. The Spring Colloquium (1 credit) will focus on research and presentation skills.
 - e) 7 credits of research, registered as ChE 596. The research credits are typically divided to 1 credit in Fall, 1 credit in Spring, and 5 credits in Summer.
 - f) Attendance to the Chemical Engineering Departmental Seminar (no credit) is required each semester the student is in residence. Students are required to miss no more than 2 seminars per semester in both the spring and the fall, unless additional absences are approved by the seminar instructor.
- 2) Attain a grade of C or higher in all courses that count towards the MS degree. A grade point average (GPA) of 3.00 or higher is required for graduation.
- 3) Present a final research poster in the last month of the one full academic year.
- 4) Complete a final research paper (typically, about 10-15 single-spaced pages, with a separate cover page).

Quick Summary for Ph.D. Students

- **Thesis Topic/Advisor Selection** within 6-10 weeks following the start of the graduate program. This will be done through the ChE 590 Colloquium in the Fall semester of the first year.
- **American English Oral Communicative Proficiency Test (AEOCPT)** – This test is required for all international students and will be scheduled by the department before the start of Fall semester of the first year. Students will be electronically notified of the date, time, and place of examination.
- **Course Requirements**
 - *Total 24 course credits* are required. Among these, *9 credits* are *core* chemical engineering courses (ChE 524, 535, and 544) from which students must get a GPA of 3.33 or higher (and no C grade in any of core courses) to qualify for the Qualifying exam. At least, *15 credits* should be in the 500-level courses in Chemical Engineering. Advanced 400-level undergraduate elective courses may be used to meet the course requirement if a written consent from the research advisor is provided. An independent study (ChE 596) may be counted toward the 24-credit course requirement *only if* it is course-based (not research-based) and the Associate Head approves it after reviewing the syllabus.
 - A maximum of 12 credits of high-quality graduate work earned from another graduate program may be accepted in partial fulfillment of course requirements for the Ph.D. degree in the McWhirter Graduate Program. This transfer process requires submission of full class materials from such courses taken in the previous institution (including the contact information of the course instructor) and the submitted materials will be evaluated by the pertinent course instructor or the Associate Head for the Graduate Program. The final recommendation for the acceptance of the submitted credits will be made based on this evaluation.
- **Departmental Seminar (ChE 597) & Colloquium (ChE 590)**
 - Attending the Chemical Engineering departmental seminar (ChE 597, 1 credit) is required every semester until the student passes the comprehensive exam.
 - In the Fall Colloquium (ChE 590, 1 credit), the faculty presents their research projects, and the advisor selection process is conducted; also, the "[Scholarship and Research Integrity](#)" (SARI) requirement is completed in the Fall. The Spring Colloquium (ChE 590) will focus on research and presentation skills.
- **Qualifying Exam** is usually scheduled early in August before the start of the fall semester of the second year. Students must meet the Ph.D. eligibility requirement with a GPA of 3.33 in core courses before the exam can be taken. Note that the qualifying exam also serves as the English Competency Test which is required by the Graduate School.
- **Appointment of Ph.D. Committee:** After passing the qualifying exam, consult with the research advisor to identify appropriate committee members and see Cathy Krause to complete the doctoral committee appointment form. All signatures of the committee members must be obtained by the end of April of the second year.
- **Comprehensive Examination**
 - Should be scheduled as soon as possible and no later than the end of the 2nd year of graduate

- program. Students must be registered for the summer semester through the [Summer Tuition Assistance Program \(STAP\)](#) if the comprehensive exam is taken in the summer.
- Notify Cathy Krause **at least 3 weeks prior** to the proposed exam date. Two weeks prior to proposed exam date, submit the comprehensive exam research proposal (the format can be found on page 21) to the doctoral committee and a copy to Cathy Krause. Notify Cathy Krause upon successful completion of the comprehensive exam.
 - Students must have a cumulative GPA of at least 3.00 to be allowed to schedule the exam. No missing or deferred grades can appear on the student's transcript when the oral comprehensive is scheduled.
- **Chemical Engineering Research Symposium**
 - All PhD students will participate in the department research symposium at the beginning of their fourth year. The symposium is usually scheduled in early September every year.
 - **TA requirement**
 - A teaching experience is an integral part of a graduate education; for students starting in Fall 2019 and after, *two semesters* as a TA in classroom and/or laboratory will satisfy this academic requirement. Note that the TA requirement could be reduced to one semester, depending on the departmental need and the research progress of individual student, but not guaranteed.
 - **Final Dissertation Defense**
 - Students must be registered for the semester in which the final doctoral defense is scheduled. If the final defense is scheduled in the Summer, registration should be done through the [STAP](#).
 - Notify Cathy Krause **at least 3 weeks prior** to the proposed exam date.
 - Submit the thesis draft to the doctoral committee, two weeks prior to the proposed exam date.
 - Students must have a cumulative GPA of at least 3.00 to be allowed to schedule the exam. No missing or deferred grades can appear on a student's transcript when the final oral dissertation defense is scheduled. No more than 12 credits of thesis research (600/610) may be assigned a quality letter grade. Any credits over this maximum must be changed to 'R' before a student will be permitted to graduate.
 - All requirements including submission of the thesis must be completed within **eight years** of the candidacy date.
 - **Dissertation Acceptance**
 - Completion of all requirements for the Ph.D. degree program entails the acceptance of the dissertation meeting (i) the research quality standards, as indicated by the signatures of at least two-thirds of the doctoral committee, as well as the head of the graduate program, on the doctoral signature page, and (ii) the editorial standards of the Graduate School, so that it constitutes a suitable archival document for inclusion in the University Libraries.
 - **Before Departure from the University**
 - Upon the completion of all requirements and earning the degree, the department needs to submit the [Initiate A Separation](#) form to the Human Resources. To initiate this process, students must see Cathy Krause.

APPOINTMENTS

Graduate students may receive appointments as Graduate Assistants, Teaching Assistants or Fellows. The normal appointment offered to new graduate students in Chemical Engineering is the **half-time Graduate Assistantship Grade 16**. The graduate assistantship requires the student to carry out research which culminates in a thesis/dissertation satisfying the requirements for a graduate degree. Fellowships are offered to incoming and continuing students on a merit basis. The evaluation of the credential of the graduate students and the decision on fellowships are made by the Graduate School. The department nominates suitable candidates for the fellowship competition to the Graduate School.

GRADUATE ASSISTANTSHIP

- Appointments are based on "superior ability and promise". Reappointment to an assistantship is based on the quality of the student's work.
- Half-Time - The student normally schedules 9-12 credits per semester, receives a stipend plus a grant-in aid of resident education tuition, and performs tasks that, on the average, occupy approximately 20+ hours per week.
- Graduate School Fellowship - Awarded by the Graduate School to a limited number of scholastically outstanding students. Fellows receive a stipend plus payment of tuition. Fellows are required to enroll as full-time students.
- Students supported by external organizations (such as companies, other universities, foreign governments) or by scholarships or fellowships (including from both internal organizations affiliated to Penn State such as College of Engineering or Graduate School and external sources such as federal agencies or private foundations) are categorized as non-departmentally supported students. These students **may not** receive stipends concurrently from two sources (for example, non-departmental and departmental funds). A one-time top-up award may be arranged for such students (especially, students with scholarships or fellowships) in recognition of their accomplishment, which can be used to support scholarly activities that are not covered by the non-departmental scholarships or fellowships. If the financial support from the non-departmental resources is less than the half-time Graduate Assistantship Grade 16, then the department and/or the research advisor will try to subsidize the deficit with the available resources. When the non-departmental support expires, the students will be eligible for the financial support from the department (usually, through the grant of the research advisor of the student). Note that all additional financial aid or offer beyond the half-time Graduate Assistantship Grade 16 is subject to the availability of such funds in the department.
- The audited course credits cannot be counted toward the minimum credits needed for the graduate assistantship. The special language courses are exceptions. The student may register for credit or audit beyond the required minimum but may not exceed the normal maximum without special permission from the Associate Head for the McWhirter Graduate Program while being supported by the graduate assistantship.
- No graduate assistant may accept other employment during the time the assistantship is held without the concurrence of both the student's advisor and the Department Head.

RESIDENCE TIME LIMITS

Completion of the Ph.D. degree requires demonstrated mastery of a body of knowledge, a set of skills, and evidence of embodying essential professional attributes. B.S. chemical engineers entering the graduate program are expected, on average, to obtain the Ph.D. degree in 5 years from their admission to the program. Outstanding students often complete their studies in less than 5 years. For graduate students on externally supported projects, funding can be extended beyond the general guidelines at the discretion of the faculty advisor. The Graduate School policy is that a doctoral student is required to complete the program, including acceptance of the doctoral dissertation, **within 8 years after the date of successful completion of the qualifying exam.**

ALLOWED VACATION TIME

Graduate Assistants, who are appointed for 18 weeks of work for each semester and an additional 12 weeks during the summer, are allowed a total of four weeks of vacation (including Thanksgiving, Christmas, and New Year holidays) during the calendar year.

UNSATISFACTORY SCHOLARSHIP

A graduate student who fails to maintain satisfactory scholarship or to make acceptable progress in a degree program may be dropped from the University. One or more failing grades or a cumulative GPA below 3.00 for any semester and the negligence of required research activities may be considered as evidence of failure to maintain satisfactory scholarship. Action may be initiated by the department, the committee in charge of the graduate major, or by the chair of the student's doctoral committee (typically, research advisor). The procedures to be followed in such action are found in the Appendix of this Handbook.

GENERAL REQUIREMENTS

TEACHING REQUIREMENT FOR Ph.D. DEGREES

A teaching experience is an integral part of a graduate education. Therefore, the department requires all graduate Ph.D. students to serve as teaching assistants before they can receive their graduate degrees. Two semesters as a TA in classroom and/or laboratory will satisfy this academic requirement (applied to students starting in Fall 2019 and after). Note that the work as a graduate grader is not considered as satisfying the TA requirement. Additional semesters of TA duty can occur if the student is interested in additional teaching experience or if a TA appointment is needed to provide financial support. Students serving as TAs to meet their degree requirement will receive the normal stipend given to the RA student. Although not required, M.S. students may also serve as TA if positions are available.

ENGINEERING 888 - Seminar/Engineering TAs

All TAs in Chemical Engineering whose duties include direct interactions with undergraduate students must satisfy the College requirements for TAs by formally registering for the 1 credit course ENGR 888. This course is required for TAs who will have significant responsibilities for classroom interactions with undergraduate students. *The registration and course participation are the best if that is done concurrently with the performance of TA duties.* ENGR 888 covers teaching methods and theories with

focuses on practical information that students can effectively use in their position. The course will be taught in a blended format, with most of the course content and assignments administered online. Students will meet in-person for three sessions during the semester.

Teaching Fellow Program

The Teaching Fellow Program provides an enhanced teaching experience for graduate students who may be considering an academic career, with the goal of encouraging students to pursue academia while at the same time assisting them in developing their teaching skills and teaching portfolio. Teaching Fellow will co-teach a Chemical Engineering course with a faculty mentor, becoming involved in all aspects of the course (lecturing, developing new course materials, preparing problem sets and exam questions, grading, etc.). The faculty mentor will provide the support and critical feedback needed for the development of effective teaching skills.

Application Process:

The student interested in being a Teaching Fellow should submit to the Department Head the following material at least 3 months prior to the start of the semester in which he/she would like to teach:

- A short write-up explaining the teaching interest / experience and how being a Teaching Fellow would fit into his/her current career plans.
- A list of the courses interested in co-teaching.
- A short letter / e-mail of support from the faculty the student has previously worked with as a TA.
- A short letter / e-mail of support from the thesis advisor

The student should discuss the plan for being a Teaching Fellow with his/her advisor as well as talk with the faculty who are teaching the courses of interest to get a better idea of their expectations. Priority will be given to graduate students who have already completed the minimum TA requirement.

CHEMICAL ENGINEERING COLLOQUIUM (ChE 590, Fall Semester)

Each Fall Semester, the faculty will give short presentations on their current research projects to all new graduate students, which will be coordinated with a series of orientations such as computer facilities, documenting research, laboratory safety, and responsible conduct of research. Students will select their thesis research topics after completion of the faculty presentations, typically about 6 to 10 weeks from the start of the semester. Also, the [Scholarship and Research Integrity \(SARI\)](#) requirements are completed in this class. The grading system to be used will be a R grade.

CHEMICAL ENGINEERING COLLOQUIUM (ChE 590, Spring Semester)

This one credit course offered each Spring Semester gives graduate students the opportunity to develop their skills at giving oral research presentations and evaluating such presentations. Other professional development skills will also be covered in collaboration with [Schreyer Institute for Teaching Excellence](#) and [English for Professional Purposes Intercultural Center \(EPPIC\)](#). Ph.D. students typically take this course during the Spring semester of their second year. All graduate students are required to take this course once during their tenure and give a presentation on a topic of their choice. The evaluation of a student's performance in the course will be based on the presentation of the individual student and his/her participation in the evaluation of other student's presentations. The grading system to be used will be an R grade.

DEPARTMENT SEMINARS

The department schedules a regular seminar series each semester for all the graduate students and the faculty. Faculty members from various universities and scientists from government and industry are invited as the seminar speakers. Seminars are a key part of graduate education and **all graduate students enrolled in our department are required to regularly attend the lectures and discussions**. All students should register for the Department Seminar course (currently ChE 597 - ChE Seminar, 1 credit) every semester up until completion of their comprehensive exam. Note that this credit does not count toward the 24 credit requirements.

LABORATORY SAFETY

Graduate students must follow safe laboratory practices. The department maintains an active Laboratory Safety Committee composed of faculty, staff and students who carry out periodic laboratory inspections. Students are expected to be responsive to the safety improvements suggested by the committee, and to serve on the committee when asked. *All graduate students must receive EHS safety training from the University, and a copy of the EHS certificate should be kept on file in each laboratory where the student works.* The safety training for all new graduate students will be done during the orientation (typically held the week before the Fall semester begins). Questions about safety issues should be addressed to the Department's Safety Officer (**Roger Dunlap**). Additional information can be obtained from the [University's Environmental Health and Safety website](#).

THESIS INFORMATION

SELECTION OF A THESIS RESEARCH TOPIC

The department wishes all graduate students to *have as much free choice as possible in selecting a thesis topic, within the confines of the department's financial resources and faculty interest*. At the beginning of the Fall Semester, new students entering the graduate program will listen to the presentations of available thesis topics from all faculty members who offer PhD research positions. These presentations will be made during the ChE 590 Colloquium class; all relevant materials will be uploaded to the Canvas. During the 6-8 week period in which these presentations are made, new students will have the opportunity to speak to all faculty members offering thesis research topics on a person-to-person basis. The purpose of these meetings is to allow an in-depth investigation of the thesis topics available. It is expected that each student will speak to all faculty members having thesis topics that are of his/her interest (minimum, three). The meetings also allow the faculty to evaluate the students as potential research assistants in their laboratory.

At the completion of the presentations of all projects offered to the new incoming students, everyone must choose at least three topics and the order of preference should be indicated by numbers 1, 2, and 3 for first, second, and third choices with a brief description about the project and their interests and qualifications. This information will be submitted to the Associate Head for the McWhirter Graduate Program through ChE 590 Canvas.

Matching thesis research topics to students' choices will be determined in consultation with the students and faculty members involved. Every effort will be made to assign students their first or second choices. However, students must note that individual faculty can only accommodate the limited number

of new students and that the Department has made a commitment to the faculty to provide them with sufficient students to fill available funded projects. A student who is dissatisfied with the topic assigned to him/her may appeal the decision to the Associate Head for the McWhirter Graduate Program.

There will be no seminar presentation of thesis topics by the faculty for new graduate students entering during the Spring Semester or Summer. Instead, the students will be provided with a list of available thesis topics and they must meet with the faculty members concerned on an individual basis. The listing will be available from the Associate Head for the McWhirter Graduate Program.

IF UNASSIGNED AT THE END OF THE FIRST SEMESTER

In some occasions, students may not find a project that they can work on. In that case, the department may provide financial aid for the Spring semester based on half-time TA assignment or other types of service to the department. During that period, students must proactively search for the project that they can work on. During the Summer semester, students may not receive financial aid from the department without doing research. If the student is still unassigned to a research project at the beginning of the second Fall semester, he/she may receive financial aid from the department again through a half-time TA assignment. If that student fails to find a research project again by the end of the Fall semester of his/her second year, then the student will not be eligible for further financial aid from the department and will be dismissed from the McWhirter Graduate Program for not making timely progress toward the Ph.D. degree.

CHANGING THE RESEARCH GROUP IN THE MIDDLE OF GRADUATE STUDY

Except non-departmentally supported students, most Ph.D. students are financially supported by research grants secured by the faculty. Since the research grant has a fixed duration, changing the assigned student in the middle of the project may have negative impacts on the student, that specific project and by large the university. Thus, once assigned, the Ph.D. student is expected to take ownership of the project and make the best effort to complete the project before he/she moves to another project. Although rare, a situation may arise where a Ph.D. student wishes to change the research group due to irreconcilable personality conflicts with the faculty advisor or differences in opinion about the overall research direction. In such cases, the student should initiate consultation with the Associate Head for the McWhirter Graduate Program. It is inappropriate for the student to speak to other faculty members about the situation or his/her intention prior to this consultation.

The first recommendation in such situations will be the direct conversation among the student and the faculty advisor to explore possible options for addressing the student's concerns and reconciliation. If the student and advisor are in mutual agreement that a change of research group is appropriate, the Associate Head for the McWhirter Graduate Program, upon the approval of the Department Head, will inform the faculty of the student's interest in changing thesis advisor.

If the student and advisor are unable to reach an agreement, the student should meet with the Associate Head for the McWhirter Graduate Program and the Department Head. Then, a plan will be developed to bring the ongoing research efforts to a reasonable state of completion. After the plan is implemented, the student's interest in pursuing a new thesis advisor will be announced to the faculty.

In all cases, it is the student's responsibility to meet with interested faculty members to identify a new project & advisor. If the student is unable to find a faculty willing to serve as a new thesis advisor, then the student will need to consider other options, e.g., pursuing a graduate degree in another program.

THESIS REGISTRATION AND GRADING POLICY

Graduate students normally register for thesis research using the course number ChE 600. Those who have passed the Ph.D. comprehensive exam register under ChE 601 (for 0 credits). The thesis work is graded according to the policy adopted by the Graduate Council. The normal passing grade assigned is R. Letter grades are not to be given for Ch E 600, except F for a failing performance. At the completion of a degree program, a specified maximum number of research credits may be changed from R to a letter grade. This change is not required for graduation purposes but merely permitted if a student and his/her thesis advisor choose to do so.

LEAVING BEFORE COMPLETION OF A THESIS

Some students may consider leaving the department to accept employment before their theses are completed and accepted by the Graduate School. A graduate student who has completed all degree requirements except thesis submission and defense must register for one credit of ChE 610 or 611 each semester (or its equivalent) for the semester and all succeeding semesters following departure from the university campus. Graduate students will be financially responsible for paying the cost of tuition each semester.

CHANGING FROM PHD TO MS

Graduate students who are originally admitted to the Ph.D. program may wish to change their path to a MS degree. If this decision is made before the completion of the first year, they may have an option of pursuing the Non-Thesis MS program (which requires meeting a different set of requirements). If the student passes the Ph.D. qualifying exam and wishes or needs to leave before the completion of the Ph.D. degree and meets the [requirements for the MS degree](#) set by the Graduate School, then the decision to grant a MS degree will be made in mutual agreement between the student and the faculty advisor. In this case, the student is required to complete a MS thesis based on the research that has been done by that time.

IMPORTANT TIMELINE

The graduating student should be aware of specific deadlines relating to all obligations which must be met during their last semester or summer session before graduation. The updated information is available at [The Thesis, Dissertation, Performance and Oral Presentation Deadlines Calendar](#) available at the Graduate School website.

GRADUATE COURSE OFFERINGS

Core Courses (Required):

- Ch E 524** **Chemical Engineering Applications of Thermodynamics (3).** Thermodynamics of pure fluids and fluid mixtures with emphasis on applications to phase equilibria calculations of importance in Chemical Engineering.
- Ch E 535** **Chemical Reaction Engineering (3).** Optimal design of batch and continuous chemical reactors and reactor batteries; effect of mixing on reactor operation.
- Ch E 544** **General Transport Phenomena (3).** Formulation and solution of transport problems involving momentum, heat, and mass transfer, with chemical engineering applications.

Elective Courses:

- Ch E 510** **Characterization of Material Interfaces (3).** This course reviews undergraduate-level chemistry, physical chemistry and physics relevant to surface and interface characterizations and studies how these basic principles are applied to state-of-the-art materials characterization techniques.
- Ch E 512** **Optimization & Biological Networks (3).** This course focuses on the principles and applications of mathematical optimization in biological systems. The first part of the course addresses optimization theory, solution algorithms, and implementation software. The latter part of the course concentrates on applying the tools necessary to address the challenges arising in biological networks.
- Ch E 528** **Colloidal Forces and Thermodynamics (3).** Unified treatment of formation, growth and stability of colloids based on principles of intermolecular and colloidal forces and thermodynamics. Prerequisite: CHEM 451, ChE 320 or an equivalent background in chemical thermodynamics.
- Ch E 536** **Heterogeneous Catalysis (3).** Thermodynamics and kinetics of adsorption and reactions on solid surfaces, heat and mass transfer effects, theory and correlations in catalysis, Prerequisites: CHEM 450, 452.
- Ch E 576** **Environmental Transport Processes (3).** Fundamentals of chemical transport in engineered environments, such as biofilm reactors, and natural systems including aquifers and rivers (co-listed as C E 576). Prerequisite: C E 475
- Ch E 597** **Special Topics** (this list changes every semester):
- Bioprocess Engineering (3).** Principles of engineering applied to biochemical production, with emphasis on biochemical separations, microbial growth kinetics, and enzyme catalysis.
- Numerical Methods in Chemical Engineering (3).** Application of numerical analysis and computational methods to the solution of algebraic and differential equations of relevance to chemical engineering.
- Non-Linear Optimization: Fundamental and Applications (3).** Fundamentals of optimization and applications in Chemical Engineering.
- Surfactant Self-Assembly (3).** The course discusses quantitative, predictive theories for diverse self-assembly phenomena such as micellization, solubilization, micro-

emulsification, and surfactant-polymer interactions developed on the basis of molecular thermodynamic methods.

Modern Control Approaches (3). Introduction to state-space methods for the analysis of dynamic systems and the design of observers to monitor the process and controllers to regulate the process to a desired trajectory.

Simulation techniques and applications (3). This course will present the quantum chemistry platform (Gaussian) and molecular dynamics simulation (Gromacs) techniques, as applied to common situations in soft matter, to gain insight into and predict values for important material properties.

Atomistic-scale simulations for Engineers (3).

Electroactive and Conductive Polymers (3).

Cellular Biophysics (3).

Membrane Separation (3).

Polymer & Complex Fluids (3).

Note: Any course with a grade C or lower will not be counted toward the 24-credit course requirement.

A comprehensive list of other elective courses can be found in the Appendix.

All first-year students are required to take three core courses in their first Fall semester, unless some of those courses are waived through the credit transfer from the previous graduate institution. A student with a non-ChE BS degree may consult with the Associate Head and decide to take only two core course in the first Fall semester; then, the rest

CONTINUOUS REGISTRATION REQUIREMENT

ChE 600/610 - If the student needs to maintain full-time student status before the comprehensive exam, he/she should register for the appropriate number of *Thesis Research* 600 (on campus) or 610 (off campus) credits which accurately reflects the amount of research being done on the thesis (number of credits to be determined in consultation with student's advisor).

ChE 601/611 – All Ph.D. students must register continuously this *PhD Dissertation* 601 or 611 credit (601 would be the appropriate registration for most students) starting with the semester after passing the comprehensive exam. The 601 students must be devoting their efforts entirely to thesis research and writing (i.e. no courses)..

If a student is in the continuous registration stage of the program, registration must be maintained each semester up to and including the semester the final oral exam (Thesis Defense) is scheduled. If the student is not on campus during the summer and is not using University facilities or faculty, registration in the summer is not required (except as noted below).

Note: Students should register for ChE 601 (for 0 credits) through the [STAP](#) if they are defending their thesis during the summer. This requirement also applies to the comprehensive exam.

Note: If a student defends the final oral examination, the student does not have to register after that semester.

ADVANCING FROM NON-THESIS M.S. TO PH.D. PROGRAM

- Students in the Non-Thesis MS program desiring admission into the Ph.D. program must obtain a course GPA of 3.33 or above, based on the credits earned in the Ph.D. core courses: ChE 524, ChE 535, and ChE 544.
- Students also should take the M.S. Preliminary Exam in the same week that Ph.D. students are taking their qualifying exam (early August) and pass with the satisfactory evaluation from the committee assigned by the Associate Head. The exam format is identical to the Ph.D. qualifying exam, and students should consult the section on Ph.D. Qualifying Exam within this graduate handbook for further information on the content and the evaluation.
- The evaluation committee will provide a recommendation regarding whether the student should be allowed to continue towards the Ph.D. degree.
- Once admitted to the Ph.D. program, students will get course credits at least 12 credits (three core courses plus one ChE 500-level elective course taken at Penn State) toward the course requirement for the Ph.D. degree and have the freedom to choose a new research topic among the projects available for the new Ph.D. students through the ChE 590 class in the Fall semester.

PH.D. DEGREE REQUIREMENTS

1. A minimum number of 24 credits in the 500-level (excluding 590 and department seminar) courses in Chemical Engineering and in related fields of science and engineering, including 9 credits of Chemical Engineering core courses and at least 6 credits of 500-level Chemical Engineering elective courses. With the written approval of the student's thesis adviser, a maximum of 3 credits of either ChE 596 or a 400-level course in related fields of science and engineering may be counted towards this requirement. Up to 9 credits from 500-level courses outside Chemical Engineering can be counted toward the required 24 credits. Each of the courses counting towards the required 24 credits must be passed with a grade of B- or better.
2. Core courses that must be taken are: ChE 524 (3), ChE 535 (3), and ChE 544 (3). Note: these courses must be taken prior to scheduling the Ph.D. qualifying exam. **Students must have a minimum GPA of 3.33 in these courses and a grade of B- or higher in each of these core courses** to be eligible to take the qualifying exam. Students who do not meet this requirement are required to take the MS preliminary exam, and are able to submit petition for entrance into the Ph.D. Qualifying at the completion of the MS requirement. Exceptions to the requirement for these courses to precede the qualifying exam will be considered on an individual basis, especially for students from non-Chemical Engineering undergraduate programs.
3. Graduate Student Colloquium – All Ph.D. students are required to register for ChE 590 in their first Fall Semester. Students must register for ChE 590 during one spring semester and are encouraged to do so as early as possible. In addition, students are required to make an oral presentation at the Department Research Symposium, typically during their 4th year (usually scheduled in the Fall semester).
4. Students must register with proper course or research credits every semester, following their first, until the completion of degree requirements. ChE 600 (610) is used until completion of the comprehensive exam. ChE 601 (611) is used after the comprehensive exam has been completed. Students should register for a total of 9 credits during every semester following their first semester,

using ChE 600 or ChE 601 to raise the total to 9. Students should register for the 600/601 course with their research advisor as the instructor.

5. Participation in Chemical Engineering Departmental Seminar is required each semester a student is in residence. Students should register for the seminar course (typically, 1 credit of ChE 597) every semester until they pass the comprehensive exam.
6. Students admitted to the McWhirter Graduate Program with a MS degree from another institution may request the use of up to 12 credits of graduate course work from the previous institution toward the 24 credits of course requirement. The process requires submission of full course materials from such courses taken in the previous institution (including the contact information of the course instructor) and the submitted materials will be evaluated by the pertinent course instructor or the Associate Head for the McWhirter Graduate Program. The final recommendation for the transfer credit will be made based on this evaluation. These students must complete at least 12 credits of 500 level courses at Penn State (excluding the seminar and ChE 590 requirement) of which at least 6 credits must be in the Ch E 500 series.
7. Completion of all 500 and 600 level credits (including 400-level credits with thesis advisor's approval) with a GPA of 3.00 or higher.
8. Completion of the minimum requirement of Teaching Assistantship.
9. Completion of the [SARI](#) requirement.

American English Oral Communicative Proficiency Test for International Students

All international students who have not completed an academic program in a U.S. university are required to take the American English Oral Communicative Proficiency Test (AEOCPT) administered by the Department of Linguistics and Applied Languages Studies at Penn State. The test date will be scheduled by the department (before the Fall semester of the first academic year) and announced to the students who need to take this test. The results from this test are used to recommend remedial steps, if necessary, to be taken by the graduate student.

The Center's evaluation is done in terms of the following proficiency codes:

NR = No Restrictions (PSU AEOCPT Score of = 250-300): This person will be allowed to teach with no restrictions based on ability to communicate in English.

WR (PSU AEOCPT Score of = 230-249): This person *will not* be allowed to do TA before completing and receiving a grade of "A" in ESL 118G.

TC (AEOCPT Score of = 200-229): This person *will not* be allowed to do TA before completing and receiving a grade of "A" in both ESL117G and ESL 118G.

SL (AEOCPT Score below = 200): This person should enroll in ESL 115G and receive a grade of "A", and then complete both ESL 117G and ESL 118G.

Students that have taken the Test of Spoken English (TSE) before arriving at Penn State should see Cathy Krause for assistance in interpreting their scores. Information concerning the TSE can be obtained from the Programming English as a Second Language, 305 Sparks Building, 865-7365.

PH.D. QUALIFYING EXAMINATION

The objectives of the qualifying exam are to assess whether a student has the necessary background and skills to successfully pursue a Ph.D. in chemical engineering, and to provide an opportunity for the student to obtain guidance and feedback from multiple faculties on their short-term research objectives and direction. The exam is composed of an oral component to take place at the end of the first year and a written component due two weeks prior to the oral exam.

The Qualifying Exam should be treated as a white paper for the Ph.D. thesis research. The exam will be centered on the development of the student's initial research efforts, and the deliverables of the exam must contain the following:

1. Brief introduction of the broad motivation and objectives of the research task described during the exam, including a short summary of critical literature relevant to the field
2. Description of the approach taken and relevant technique(s)
3. Summary of recent research efforts by the student
Note: *Presentation of preliminary results on your project is desirable but not required for the qualifying exam.* Examples of research efforts include, but are not limited to, experiments, computations, technique development, data interpretation, and mastery of a research-related technique.
4. Description of the research plan and direction for the next 9 months to a year

Criteria for a successful exam and possible outcomes

Students will be assessed through a written report, oral presentation (15-20 min), and responses to questions after the oral presentation (20-30 min). Altogether, the oral exam will last no more than 50-55 min. *The written report is to be a maximum of 5 single-spaced pages, including everything except references. The margin of the page must be 1", and the font size must be 11 pt if Calibri or Arial fonts are used / 12 pt if Time New Roman is used.* The written report should include a brief introduction, the rationale for the research, the hypothesis to be tested, the general approach to be used, and any specific aims. In developing the document, the student may confer with his or her advisor regarding the availability of background materials, and the formulation of the research objectives. However, the writing and editing of the written report should be the exclusive work of the student because it will be used by the Department to satisfy the University's requirement for the English Competency Exam.

In order to successfully pass the qualifying exam, a student must:

1. Demonstrate mastery of chemical engineering fundamentals
2. Demonstrate understanding of the scientific method (observation, hypothesis generation, hypothesis testing, analysis)
3. Effectively present and communicate technical ideas and concepts related to the student's research
4. Demonstrate effective verbal and written communication skills in English

Qualifying Exam Committee:

The qualifying exam committee for each student will consist of 3 graduate faculty members assigned by the Associate Head for the McWhirter Graduate Program. The student's advisor may attend the exam

but must not participate in the discussions and deliberations involving the student, except to provide specific information regarding research performance.

Scheduling of Qualifying Exam

In order to take the qualifying exam, students must first obtain a minimum GPA of 3.33 from ChE 524, ChE 535, and ChE 544, AND complete each of these courses with a grade of B- or better. This requirement is to ensure that all Ph.D. students have sufficient understanding of the core chemical engineering fundamentals to pursue advanced study and professional career opportunities.

For the students to meet this GPA requirement from the first Fall semester, the Ph.D. qualifying exam will be scheduled in early August in the following year. The timing for the qualifying exam for students who start the Ph.D. program in January will be determined on an individual basis. The exact dates for the exam will depend on the availability of the faculty, and may vary from year to year. All students entering the graduate program in the Fall must take the Ph.D. qualifying exam the first time this exam is scheduled after they enter the Graduate Program. The written part of the exam must be submitted to Cathy Krause at least two weeks prior to the oral exam.

Students who do not meet this prerequisite (a GPA of 3.33 and higher from the three core courses)* will be required to take the M.S. preliminary exam (scheduled in the same week of the Ph.D. qualifying exam)** and complete a MS thesis before they can submit a petition for the exemption from the GPA requirement. The decision to allow the student to continue towards the MS degree will be made by the student's thesis advisor. Upon completion of the MS degree, the student can submit a written petition (including a letter from the thesis advisor), requesting to continue working toward the PhD study. Petitions will be discussed among the entire faculty and will be granted only if the student has demonstrated truly exceptional research performance, leading to publication of key research results. If the petition is approved, the completion of both M.S. preliminary exam and thesis defense will be considered equivalent to meeting the Ph.D. qualifying exam and the student will be allowed to continue the Ph.D. study.

* The core course with a grade C or lower needs to be re-taken to continue in the PhD path after passing the M.S. preliminary exam.

** For the student in the M.S. track who *performs exceptionally outstanding at the M.S. preliminary exam*, the exam committee and the faculty advisor can suggest waiving the 3.33 GPA prerequisite and placing the student back to the normal track of the PhD program. Then, the suggested waiver will be discussed at the faculty meeting and granted upon approval of the majority of faculty attending that meeting.

Criterion of Research Performance:

Research performance from the thesis advisor will be used as an additional criterion in making the pass/fail decisions on the qualifying exam. The thesis advisor will be asked to present the qualifying exam committee with a written evaluation of the research performance of the student. If the student completes the M.S. thesis with a different advisor, she/he will also be asked to present the committee with an evaluation of the student's M.S. thesis research performance.

The examination committee is entitled to inquire into any aspect of the student's preparation and progress. Failure of the student to demonstrate one or more of the criteria listed above will result in failure of the Exam. *At the discretion of the exam committee, a maximum of one retake may be allowed for any student.* If a retake of the Exam is recommended by the exam committee, the retake must take place before the end of the fall semester of the second year with the same committee, and its scheduling will be the responsibility of the student. Unless otherwise specified by the exam committee, students who do not pass the Qualifying Exam will be required to first complete a M.S. thesis before they can petition to move onto the regular track of the Ph.D. program.

English Competency Evaluation through Ph.D. Qualifying Exam

All Ph.D. students, domestic and international, will undergo an assessment of English competency during their first year. The assessment will include the student's ability to read and comprehend to participate in scientific and technical discussions. The assessment will be conducted during the Ph.D. qualifying exam by a committee of 3 graduate faculty members. The English Competency Testing will consist of three parts:

(a) Writing

The student will prepare a detailed research proposal on the topic chosen for his/her doctoral dissertation. The written proposal should include, as appropriate, the following: (i) brief introduction, (ii) rationale for the research (what problems motivate this research?), (iii) hypothesis to be tested, (iv) general approach to be used, (v) tentative timetable for completion of research.

The written document will be judged for its organization, the logical arguments in support of the student's hypotheses, the inclusion of relevant details, and style in the use of language, grammar, punctuation and spelling. The written document must be the individual work of the student and no editing of the written proposal by the student's thesis advisor is to be done.

(b) Formal Presentation

The student will make a formal presentation of the thesis proposal before a faculty committee, after a period of at least two weeks following the submission of the written thesis proposal. Typically, the formal presentation will be of about 20 minutes duration. The presentation will be judged for its clarity, adaptation to the audience, organization, appropriate use of visual aids and effectiveness of delivery. The quality of the formal presentation should be comparable to papers presented at the technical sessions of professional society meetings (such as AIChE Annual meeting).

(c) Oral Discussion

The main purpose of the oral examination part of the English Competency Test is to evaluate the oral skills of the student to participate in scientific and technical discussions with other technical professionals, who may not necessarily be specialists. The oral examination will follow the formal presentation of the research proposal by the student. The examination committee will conduct a discussion with the student on all aspects of the research proposal and also on the scientific and technical issues surrounding the research area.

At the end of the qualifying exam, each member of the committee will present an assessment of student's English competency in the three categories: writing, formal presentation and oral discussion. These assessments will be used to certify the attainment of English competency for students judged to be competent and to recommend measures for improving their English competency for students judged to be deficient.

Improving English Competency of Students with Deficiencies

If the expected level of competence is not demonstrated, the student will be required to enroll in course(s) offered at the university to improve English competency. The committee may recommend the suitable course(s), workshops, or consultation sessions. Examples include:

- (i) Oral Language Skills: ESL 114G (American Oral English for Academic Purposes), ESL 115G (American Oral English for ITAs I)
- (iii) Writing Skills: ESL 116G (Composition for Academic Disciplines), ENGL 202C (Effective Writing: Technical Writing), ENGL 198G (Writing in the Disciplines)
- (iv) Communication skills: Individual consultations or workshops offered by [English for Professional Purposes Intercultural Center \(EPPIC\)](#)

If the student completes and passes the recommended steps with satisfactory grades or evaluations, then the student will be certified as having attained English competency. Students judged as not making sufficient progress towards achieving competency in English will have their funding terminated.

Further Opportunities for Enhancement of English Competency

The department has two additional requirements designed to enhance the English competency of all doctoral students – Colloquium (ChE 590 in the Spring semester, 1 credit) and Department Research Symposium (typically in the Fall semester of student's 4th year).

Graduate Minors

A [Graduate Minor](#) may be taken in one of the approved graduate degree programs offered at Penn State. A doctoral minor consists of no fewer than 15 graduate credits of integrated or articulated work in one field related to, but different from, that of the major with a preponderance of courses at the 500 level; however, at a minimum, 6 credits must be at the 500 level.

A student seeking a minor must have the approval of the student's major program of study, the minor program, and the Graduate School. *Official requests to add a minor to a doctoral candidate's academic record must be submitted to Graduate Enrollment Services prior to establishing the doctoral committee and prior to scheduling the comprehensive examination.*

APPOINTMENT OF DOCTORAL COMMITTEE

- A. After the student passes the Ph.D. qualifying exam and before he/she takes the comprehensive exam, members of the doctoral committee must be appointed. The doctoral committee is nominated to the Graduate School by the Associate Head for the McWhirter Graduate Program, based upon input from the student and the student's adviser.

- B. The doctoral committee is to consist of at least 3 graduate faculty members in the major field (Chemical Engineering) and at least 1 faculty member outside the major field (called “Outside Unit Member”). The committee chair will ordinarily be the candidate's research advisor.

The primary duties of the chair are to: (1) maintain the academic standards of the doctoral program, Graduate Council, and the Graduate School and assure that all procedures are carried out fairly, (2) ensure that the comprehensive examination and final oral examination are conducted in a timely fashion, and (3) ensure that requirements set forth by the committee are implemented in the final version of the dissertation.

The outside side member shall have no conflicts of interest with the department of the student such as a budgetary connection to the department or serving as a co-principal investigator with any other members of the committee. The primary responsibilities of this outside member are (1) to maintain the academic standards of the Graduate School and (2) to assure that all procedures are carried out fairly.

- C. Following the [GCAC 602](#) policy, the committee should meet with the student at least once a year to review the progress of the research at the call of the advisor or the student. When the student is ready to write the first draft of the dissertation, he/she may schedule a committee meeting to present his/her results for discussion and criticism.
- D. The student's doctoral committee has the responsibility to guide the course of study undertaken by the student.
- E. If a student is pursuing a [Graduate Minor](#), then at least one member of the Doctoral Committee must be a member of that Department.
- F. A person who has particular expertise in the candidate's research area but is not a member of the Graduate Faculty (either affiliated with Penn State or not) may be added as a “Special Member,” upon recommendation by the thesis advisor and the Associate Head for the McWhirter Graduate Program and approval of the director of Graduate Enrollment Services.
- G. Graduate Faculty officially appointed by the Graduate School to a doctoral committee who then leave Penn State may maintain that committee appointment for up to one year if the student's graduate program and the dean of the Graduate School, through the Office of Graduate Enrollment Services, approve the request for this exception. A retired or emeritus faculty member may serve as a doctoral committee chair if, and only if, he/she was officially appointed and began chairing the committee prior to retirement and has the continuing approval of the program head and the dean of the Graduate School, through the Office of Graduate Enrollment Services. Requests must be sent by the program head to the director of Graduate Enrollment Services.
- H. The membership of doctoral committees will be reviewed periodically by the Associate Head of the McWhirter Graduate Program to ensure that all members continue to qualify for service on the committee in their designated roles. If changes are warranted, they must be made as soon as possible to prevent future problems that may delay academic progress for the student.

PH.D. COMPREHENSIVE EXAMINATION

A comprehensive exam is required for all doctoral candidates by the Graduate School. As partial fulfillment of the requirements for the comprehensive exam, the candidate must submit a dissertation

proposal. The finished report must be presented in writing to the candidate's doctoral committee and defended orally after it has been accepted. The comprehensive exam should be completed within 2 years after joining the Ph.D. program.

The dissertation proposal should be of the same nature and quality as would normally be submitted to a funding agency such as the National Science Foundation - i.e., it should define a significant problem, review the current literature and provide a critical review of the state-of-the-art, propose methods of investigation, and contribute some significant new information, data, or preliminary results which could be submitted to research sponsors or for publication in a journal. *A simple compilation of the published papers will not be accepted as the dissertation proposal*; it is recommended that the dissertation proposal be prepared by adhering to the guidelines provided for research proposals submitted to the National Science Foundation.

The size of the main body of the proposal is limited to 15 single-spaced pages with 1" margins and using a font size of 11 pt if Calibri or Arial fonts are used / 12 pt if Time New Roman is used. These are upper limits, and do not preclude shorter documents that convey the needed material. The pdf file for the written document must be submitted electronically to Cathy Krause at least two weeks before the scheduled exam date. The written document will be checked for format and length requirements, and then distributed to the Doctoral Committee for review. Please note that written reports that do not meet the format and length requirements will be returned to the student. In such cases, the exam will need to be rescheduled.

The candidate will be responsible for arranging a time for the oral defense of the dissertation proposal. The oral defense will consist of a **30-minute presentation** by the candidate on the highlights of the work, followed by questions from the Doctoral Committee. The oral defense of the proposal is intended to help the candidate develop better technical communication skills as well as demonstrate his/her knowledge of the area. This oral examination must be officially scheduled through the Graduate School at least three weeks prior to the date of the exam. Students should note that in order to schedule the Ph.D. comprehensive exam, they must have successfully completed the English competency requirements. It is expected that all the course requirements for the Ph.D. degree will be completed by the end of the semester in which the student completes the comprehensive exam.

The doctoral committee is entitled to inquire into any aspect of the dissertation proposal. Failure of the student to demonstrate the research competency will result in failure of the exam. At the discretion of the doctoral committee, a maximum of one retake may be allowed. The specific deficiencies to make up as well as the retake timing will be recommended by the committee, and the retake exam scheduling will be the responsibility of the student. The doctoral committee can also decide whether the student should graduate with the M.S. degree (with full thesis defense) or be terminated from the program immediately.

Note: When a period of more than 6 years has elapsed after passing the comprehensive exam, the student is required to pass a second comprehensive exam before the final oral exam will be scheduled. This should be should at least 3 months before the final oral dissertation defense.

AWARDS

The McWhirter Graduate Program is fully committed to recognizing outstanding performance of our graduate students. The department provides special [awards](#) to recognize graduate student(s) whose performance has been particularly outstanding every year. The award categories are as follows:

Walter L. Robb Fellowship for Outstanding Performance on Qualifying Exam

Excellence in Teaching

Annual Competition for Best Paper

Best Presentation Award at the Chemical Engineering Research Symposium

The Robb Fellowships will be made by the Department Head in consultation with the faculty and the Associate Head for the McWhirter Graduate Program. Decisions on the best TA, paper, and presentation awards will be made by the McWhirter Graduate Program Committee.

The department has a limited resource to help students who have no sources of travel funds to attend a conference. If you have research outcome that you wish to present a national conference, but your advisor does not have funding to support your travel, then you may contact the Associate Head to check the availability of funding and your qualification for the travel support.

EXTERNAL INTERNSHIP

Although the department does not have a formal internship program, many students find it useful to work in industry or a government agency during their doctoral program. Such an external internship is encouraged if it enhances a student's doctoral research, provides a basis of the comprehensive exam, or enriches the student's graduate education in some other specific manner. Although a formal approval for an external internship is not required for US graduate students, it should be planned with the full knowledge and cooperation of the student's advisor.

For international students, it should be noted that employment for F-1 and J-1 students is limited and working without permission is a violation of status and a deportable offense. F-1 and J-1 students may not work off-campus (such as [Curricular Practical Training \(CPT\)](#)) without prior consultation with their advisor and the [Directorate of International Student and Scholar Advising \(DISSA\)](#). If the external internship enriches the student's graduate education in their specific research topic and is central to their research towards the PhD degree, the student should seek permission from the DISSA; working without approval from the DISSA is [a deportable offense](#). Also, it should be noted that F-1 students will be responsible for course registration of the semester working under CPT (601 for Fall/Spring and 610 for summer) as well as tuition payment (except for the summer).

PH.D. DISSERTATION DEFENSE

The student will schedule a dissertation defense at least three weeks prior to the proposed exam date. After the student completes the final draft of the dissertation, it should be given to each of the

committee members at least two weeks before the date of the scheduled examination. The dissertation should be complete and in its final draft, with correct and polished content and style, appropriate notes, bibliography, tables, etc., at the time it is distributed to the committee members. If a committee member finds that the final draft is not correct and polished with respect to content and style, it is his/her responsibility to notify the committee chair/dissertation adviser at least one week in advance of the final oral examination date. The committee member should indicate his/her concerns regarding the draft and may recommend consideration of postponement of the examination to the committee chair/dissertation adviser. The chair/adviser, in consultation with committee members, is responsible for notifying the student and assessing whether the student can make the necessary revisions to the final draft before the examination date. If it is determined that revisions cannot be made in time, the final oral examination must be postponed.

The dissertation defense is to be conducted under the following guidelines:

1. All parts of the defense are to be public, except the final deliberations of the committee.
2. The student will begin the defense with a presentation of the highlights of the work which should typically not exceed 30 minutes.
3. The general audience will then be allowed to ask questions.
4. The committee will follow this with questions prepared on the basis of their study of the dissertation. This questioning will serve as the final oral examination required by the Graduate School.
5. At least two hours must be provided for the defense. The committee will then meet in the executive session.
6. If the dissertation is deemed satisfactory by at least two-thirds of the Committee who are members of the Chemical Engineering faculty, the student will pass the examination and the Committee will decide how to implement improvements in the final draft, if needed.

If the dissertation is not deemed satisfactory, it is the responsibility of the committee to determine whether another examination may be taken by the student. Upon successful completion of the defense, the student will make necessary corrections to the draft, obtain the committee's (majority) approval, and have the final copy properly formatted and edited. The student will submit the dissertation to the Graduate School and submit the required Doctoral Signatory Page. The dissertation is usually expected to be submitted in the same semester as the oral defense.

CHECK LIST OF GRADUATE SCHOOL REQUIREMENTS FOR PH.D. CANDIDATES

The following is a summary of Graduate School requirements that Ph.D. students must meet before the Office of Graduate Programs may approve their graduation. For more detailed information on these and other requirements, please refer to the [University Bulletin](#). These are the Graduate School requirements and do not include the specific department requirements:

- [Residency requirement](#). After passing the doctoral qualifying examination, students must be registered full time for two semesters in a twelve-month period. This may include the semester of qualifying exam if it is taken during spring or fall.
- A candidate for the Ph.D. must have satisfied the departmental English Competency Test before taking the comprehensive exam.

- Three or more months must have elapsed between the passing of the comprehensive exam and scheduling of the final oral examination.
- The final oral examination must be held within six years of the date the comprehensive exam was passed. If more than six years have passed, a second comprehensive exam must be completed before scheduling the final oral examination.
- Continuous registration requirement. Students must be registered continuously each semester (excluding summers without taking the oral comprehensive exam and the final oral examination) beginning with the semester following the passing of the comprehensive exam and until the final oral examination is passed.
- Time limitations. All requirements including submission of the thesis must be completed within eight years of the qualifying date.
- No missing or deferred grades can appear on a student's transcript when the oral comprehensive exam or the final oral examination is scheduled.
- Students must have at least a 3.0 grade point average to schedule the oral comprehensive exam and the final oral examination.
- No more than 12 credits of thesis research (600/610) may be assigned a quality letter grade. Any credits over this maximum must be changed to "R" before a student will be permitted to graduate.

Thesis and Dissertation Information

The Graduate School, the University Libraries, and the Graduate Faculty of Penn State have established format standards that a thesis or dissertation must meet before receiving final approval as fulfillment of a graduate requirement. Every thesis and dissertation must be reviewed by the Office of Theses and Dissertations for format only and are not edited for spelling, grammar, or punctuation. Master's papers are not reviewed by the Office of Theses and Dissertations.

When a thesis or dissertation is submitted to the Office of Theses and Dissertations, it must meet the formatting and [deadline](#) requirements set forth in the [Thesis and Dissertation Guide](#). Additional information can be found at [the Office of Thesis and Dissertations website](#).

Thesis Production in the Department

An electronic copy of the thesis must be submitted to the Graduate School in a pdf format. The department will print and bound one copy for the student and one copy of the advisor(s); to arrange the printing of the thesis, the pdf file of the thesis should be sent to **Lisa Haines**. Purchase of additional copies can be requested at the submission of the pdf copy. Students are responsible for their own proofreading required in connection with the thesis.

NON-THESIS MS DEGREE IN CHEMICAL ENGINEERING

The non-thesis MS track integrates fundamental Chemical Engineering concepts with a culminating chemical engineering research project. This program will provide a framework for life-long learning and problem solving via the application of advanced chemical engineering topics.

The non-thesis MS track consists of 30 credits, including 21 credits of coursework, 2 credits of colloquium, and 7 credits of research that culminates in a research project showcase (poster presentation) and paper. This program will allow students to complete a MS degree typically in 12 months, beginning in the fall and including spring and summer semesters.

A typical program of study for non-thesis MS students:

Fall Semester (14 credits)

ChE 524, Chemical Engineering Application of Thermodynamics (3)
ChE 535, Chemical Reaction Engineering (3)
ChE 544, General Transport Phenomena (3)
ChE 5XX, Graduate Elective (3)
ChE 590, Colloquium (1)
ChE 596, Independent Study (1) [supervised by the MS program coordinator]

Spring Semester (15 credits)

ChE 5XX, Graduate Elective (3)
ENGR/SCI Elective (3)
ENGR/SCI Elective (3)
ChE 590, Research Skills Development Colloquium (1)
ChE 596, Independent Study (5) [supervised by the student's research advisor]

Summer Semester (1 credit)

ChE 596, Independent Study (1) [supervised by the student's research advisor]

Though students are registered for only 1 credit of ChE 596 during the summer, they are expected to devote their full effort towards their research.

Elective Courses

The non-thesis MS degree requires 2 ChE 5XX electives and 2 ENGR/SCI electives. Students typically have room in their schedule for one elective course in the Fall. Here are some electives you might consider. Note the list of ENGR/SCI electives is not exhaustive, as any 5XX in an engineering or science discipline would be acceptable, and you are allowed to substitute one 4xx for one of the ENGR/SCI courses.

ChE 5XX elective courses [check the [LIONPATH](#) for course offering in each semester]

ChE 501, Bioengineering Transport Phenomena
ChE 510, Surface Characterization of Materials

ChE 536, Heterogeneous Catalysis
ChE 576, Environmental Transport Processes
ChE 597, Cellular Biophysics
ChE 597, SynBio: Engineering Genetic Systems

ENGR/SCI electives that may be of interest [also see the extended list in Appendix]

MATSE 501, Thermodynamics of Materials
MATSE 514, Characterization of Materials
MATSE 542, Polymeric Materials: The Solid State
MATSE 575, Functional Polymeric Materials
BIOE 512, Cell and Molecular Bioengineering
ME 550, Foundations of Engineering Systems Analysis
CHEM 525, Analytical Separations
CHEM 526, Spectroscopic Analysis
CHEM 545, Statistical Thermodynamics
FSC 504: Problems in Fuels Engineering

Advisor and Research Project Selection

During the Fall semester, MS students will be distributed a list of available research projects and advisors. Advisors will present at the ChE 590 Colloquium course, describing research in their group and the available projects. Students will then schedule individual meetings with faculty they are interested in working with. By a prescribed date, typically in early to mid-October, students will provide a ranking of their project preferences to the MS program coordinator. The faculty will meet to match students with advisors, considering preferences of the students as a priority but also considering faculty opinions on the suitability of a match to the group and the balance of students across advisors. Students will be informed of their project assignment within a few weeks of submitting their choices.

Completion of research requirements of non-thesis MS program

To complete the research requirements of the non-thesis MS program, students must:

- A) Receive a grade of C or higher in 7 credits of ChE 596, Independent Study
- B) Present a poster on their research to the faculty at the end of the summer of their first year in the program
- C) Submit and have approved their final research paper.

Poster Presentation

A poster session will be scheduled for early August, held over lunch with each student presenting their research to a small group of faculty, mainly composed of the MS Program Coordinator and other MS research advisors. Faculty will ask questions of the students and provide feedback on questions that might be answered when preparing their written document.

TENTATIVE DATE: The first Friday of August

Final Research Paper Requirements

The final research paper must represent an **academic contribution** to the field of Chemical Engineering. It should follow an academic style in its sub-discipline of ChE, typically including an *Introduction* providing the research motivation, background, and objectives/hypothesis; *Methods* section describing

the approach towards reaching the research goals; *Results* and analysis with *Discussion* in context of the field and the goals of the research; and *Conclusions*: a final set of outcomes of the work.

Figures, tables, and schematics should be used to aid in explaining and reporting the work completed. References to the published literature should be used to aid in providing background on the area and methods used, and to put the work completed in the context of the field. Bibliography format should follow Penn State thesis guidelines.

The document must represent original work prepared by the student. A typical length of the document would be 10-15 pages, single spaced, though length may vary. The document must be approved by both the research advisor and the Associate Head of the McWhirter Graduate Program. A signature sheet template must be obtained from Cathy Krause and should be signed by the research advisor and the Associate Head.

TENTATIVE DUE DATE FOR FINAL SIGNATURES: The second Wednesday of August

Graduation timing of non-thesis MS student:

Typical period of student for a non-thesis MS student is expected to be 12 calendar months, beginning with the Fall semester and ending with the completion of the research paper at the end of the following summer. The student who postpones any of the 21 credits of coursework or need to repeat a class due to a dropping or a failing grade, may do so in Fall of their second year. The student needing more time to complete their research may also extend into the Fall of their second year. During the Fall of the second year, the student may pay tuition per credit for any credits needed to graduate from the program. International student's visa may be extended without requiring full time (9 credit) enrollment during the final semester of graduation, which must be arranged with the [DISSA](#) office.

Applying to the PhD program in Chemical Engineering at Penn State:

The non-thesis MS program is not intended to serve as a step towards PhD studies in the department, and it is not expected that the MS student will automatically continue toward the PhD path. Students are welcome to apply during the normal Fall application period. Applications received at this time will be compared with external applications, and mainly judged on the student's undergraduate record. Non-thesis MS students may submit applications to the PhD program over the summer as well. For the student wishing to continue the graduate study toward the PhD degree, an oral exam following the same format as the department's PhD candidacy exam (5-page paper, 20-minute oral presentation, 30 minutes of questioning) will be scheduled to aid in the admission decision.

Transfer to the thesis MS program:

Our department does not admit students to the thesis MS program, and does not generally have an intent to have such students in The McWhirter Graduate Program. Requests to transfer to this program following completion of 12 months of MS study may be considered, with the requirement that any student in the thesis MS program be financially supported (tuition plus stipend) by their research advisor.

STUDENT ORGANIZATIONS

The [Chemical Engineering Graduate Student Association \(GSA\)](#) represents ChE graduate students in department-oriented matters. Examples of activities in which the GSA has previously been involved in are the annual spring and fall picnics, the colloquium series, safety inspections, graduate course evaluations, finding mentors for new graduate students, etc. The most important function of the GSA is to serve as a channel which graduate students can use to direct complaints, problems, or suggestions that they might have to the faculty or staff associated with the Chemical Engineering department.

The GSA consists of about ten members who are elected to the various positions listed below. These elections take place at the beginning of each academic year. Members meet once or twice a month to discuss various topics and concerns brought forth by the graduate students. It is important that the GSA is able to fill all of the positions available, for then it is able to run efficiently and effectively addresses the concerns of the graduate students. All students are encouraged to serve as a member of the GSA at some point of their graduate academic career.

The current president of GSA is **Nicholas Cross** (nrc83@psu.edu). Students who want to get involved in GSA activities are encouraged to contact the GSA president and visit the [ChE GSA](#) website.

APPENDIX

The links available in this page provide details on graduate student's responsibilities and useful guidance or information about various situations not covered in this handbook.

[Code of Conduct](#) The Pennsylvania State University recognizes the basic rights and responsibilities of the members of the University and accepts its obligation to preserve and protect those rights and responsibilities.

[Procedures for Resolution of Problems](#) These procedures pertain to a range of concerns and disagreements involving graduate students and other members of the University community.

[Termination of the Degree Program of a Graduate Student for Unsatisfactory Scholarship](#) Every graduate student is expected to exhibit and promote the highest ethical, moral, and professional standards as scholars, and as future faculty, professionals, and leaders in their respective fields. Meeting this expectation is a component of satisfactory scholarship for graduate students, in addition to meeting academic standards. A violation of ethical, moral, and/or professional standards is regarded as a serious offense may result in academic sanctions including suspension or dismissal by the graduate program and/or by the Graduate School. Where the basis for unsatisfactory scholarship is behavior that is believed to fall within the Code of Conduct, it should first be referred to the Office of Student Conduct for adjudication.

[Termination of Assistantships due to Inadequate Performance](#) The purpose of this policy is to provide guidance to units in dealing with inadequate performance by graduate assistants. This policy applies only to inadequate performance by a graduate assistant in his or her duties and responsibilities during the term of appointment. It does not apply to (i) a decision by the unit not to renew an assistantship appointment, (ii) matters involving the academic performance of the graduate assistant, and (iii) the automatic termination of an assistantship appointment when the graduate assistant is no longer a student.

[Guidelines for Extended Leave](#) Circumstances occasionally occur that prevent graduate assistants (including TAs and RAs) from performing the duties of their appointment. Instances include personal and/or family illness, injury, or childbirth. Consistent with Penn State's continuous effort to support the personal and professional development of all members of our community, these guidelines seek to reduce the professional and personal stresses that can develop when graduate assistants encounter extenuating circumstances that warrant a temporary absence from their assistantship duties, while continuing their stipend and benefits.

[Letter of Certification](#) Candidates for graduation during a particular semester may request an official letter that verifies their status with respect to meeting degree requirements and their expected graduation date. Potential employers, licensure boards, embassies and other agencies may require this type of verification, including petitions for H-1B visas.

[Recommended Practices in Graduate Education](#) This document suggests examples of recommended practices in each of three core areas for all of the key participants in graduate student education.

Tax Information: GSA TAX Guide available for pick up at 118B Kern Building. For international students, the [DISSA office](#) can provide further information.

[Resources for Reporting Wrongdoing](#) This website provides various resources to report misconduct. Penn State University encourages reporting misconduct. ***If you see something, say something.*** Also, individuals can report issues and/or ask questions via [hotline](#) or phone at 1-800-560-1637.

List of graduate elective courses that are potential interests to chemical engineering students:

Note that this list is based on Fall 2019 and Spring 2020; the actual course offering may vary and other 500 level courses are allowed. Also, there are many special topics (with the 597 course number in each department) that might be interest to chemical engineering students; such topics are offered irregularly. So, please check [LionPath](#) for the most updated course listing in each semester.

Fall Semester:

ABE 559 - Biological and Agricultural Systems Simulation
BIOE 501 - Bioengineering Transport Phenomena (co-listed as ChE 501)
BIOE 504 - Numerical Methods in Bioengineering
BIOE 509 - Mechanobiology
BIOE 512 - Cell and Molecular Bioengineering
CE 556 - Environmental Electrochemistry
CE 570 - Environmental Aquatic Chemistry
CE 574 - Reactive Transport Processes in Porous Media
CHEM 516 - Inorganic Chemistry
CHEM 518 - Symmetry and Spectroscopy in Inorganic Chemistry
CHEM 539 - Biochemical Reaction Mechanisms
EE 524 - Lasers and Optical Electronics
EMCH 524A - Mathematical Methods in Engineering
EMCH 540 - Introduction to Continuum Mechanics
EMCH 560 - Finite Element Analysis
EME 511 - Interfacial Phenomena in Energy and Mineral Systems
EME 531 - Thermodynamics of Energy and Mineral Systems
ESC 503 - Low Dimensional Nanoelectronics
ESC 518 - Bioprinting
ESC 521 - Pattern Transfer at the Nano-scale
ESC 545 - Scientific and Engineering Foundations of Additive Manufacturing
GEOSC 536 - Topics in Biogeochemistry
MATSE 504 - Solid State Materials
MATSE 514 - Characterization of Materials
MATSE 556 - Polymer and Composite Materials for Additive Manufacturing
MCIBS 503 - Critical Elements of Genetics and Molecular and Cellular Biology
MCIBS 556 - Computation, Bioinformatics, and Statistics Practicum
ME 505 - Atomistic-Scale Simulations EN (co-listed as ChE 505)
ME 512 - Heat Transfer--Conduction
ME 515 - Two-Phase Heat Transfer
ME 521 - Foundations of Fluid Mechanics I
ME 559 - Nonlinear Control and Stability
ME 560 - Solid Mechanics
PHYS 512 - Quantum Theory of Solids I
PHYS 527 - Computational Physics and Astrophysics
PHYS 530 - Theoretical Mechanics
PNG 502 - Unsteady Flow in Porous Media
STAT 503 - Design of Experiments
STAT 505 - Applied Multivariate Statistical Analysis
STAT 511 - Regression Analysis and Modeling

Spring Semester:

BIOE 508 - Biomedical Materials
BIOL 519 - Ecological and Environmental Problem Solving
BIOL 555 - Statistical Analysis of Genomics Data
CE 561 - Surface Hydrology
CE 571 - Physical-Chemical Treatment Processes
CE 572 - Biological Treatment Processes
CE 573 - Environmental Organic Chemistry
CHEM 511 - Chemical Nanoscience
CHEM 519 - Materials Chemistry
EE 520 - Electro Optics--Systems and Computing
EE 522 - Electro-Optics Laboratory
EE 526 - Nonlinear Optical Materials
EE 552 - Pattern Recognition and Machine Learning
EMCH 507 - Theory of Elasticity and Applications
EMCH 530 - Mechanical Behavior of Materials
EME 521 - Mathematical Modeling of Energy and Mineral Systems
EME 570 - Catalytic Materials
ESC 522 - Fabrication and Characterization for Top-down Nano-manufacturing
ESC 523 - Fabrication and Characterization for Bottom-up Nano-manufacturing
ESC 555 - Neuroscience Data Analysis
ESC 582 - Micro- and Nano-Structured Light Emitting Devices
FSC 504 - Problems in Fuels Engineering
GEOC 522 - Geochemistry of Aqueous Systems
GEOC 561 - Mathematical Modeling in the Geosciences
MATSE 542 - Polymeric Materials: The Solid State
MATSE 543 - Polymer Chemistry
MATSE 555 - Polymer Physics I (*this course can be counted as ChE 500-level elective*)
MCIBS 554 - Foundations in Data Driven Life Sciences
MCIBS 571 - Current Issues in Biotechnology
ME 513 - Heat Transfer--Convection
ME 514 - Heat Transfer--Radiation
ME 522 - Foundations of Fluid Mechanics II
ME 523 - Numerical Solutions Applied to Heat Transfer and Fluid Mechanics Problems
ME 530 - Fundamentals of Combustion
PHYS 513 - Quantum Theory of Solids II
PHYS 524 - Physics of Semiconductors and Devices
PHYS 557 - Electrodynamics
PNG 501 - Flow in Porous Media
PNG 520 - Thermodynamics of Hydrocarbon Fluids
STAT 500 - Applied Statistics
STAT 501 - Regression Methods
STAT 502 - Analysis of Variance and Design of Experiments
STAT 515 - Stochastic Processes and Monte Carlo Methods
STAT 557 - Data Mining I
STAT 565 - Multivariate Analysis

The departmental policy for a student transferring from another institution following the faculty member who is moving to Penn State:

- (i) The student must apply to the program through the Graduate School website. Then, the Admissions Committee will immediately review the application and make the admission offer if appropriate.
- (ii) All students will be required to meet the qualifying exam requirement. The assessment format may be different from the qualifying exam that all PSU students take; but, it requires an evaluation by the faculty that meets the primary purpose of the exam as stated in [GCAC 604 – Qualifying Exam](#). The assessment:
 - a. cannot be held until after the student is admitted and enrolled at Penn State as a graduate student in the PhD program;
 - b. will be in the form of a meeting with the committee, presenting the research work (to be done or accomplished so far) following with Q&A;
 - c. must be reported to Graduate Enrollment Services within 30 days; and
 - d. done prior to taking the comprehensive exam.
- (iii) For transfer students wanting to take the comprehensive exam in the first semester of enrollment, transcripts documenting grades from the previous institution will be permitted for meeting the 3.0 minimum GPA requirement and will be accepted in lieu of completed PSU coursework (exception). This must be done prior to taking the comprehensive exam at Penn State.
 - a. Official transcripts must be on file with the Graduate Enrollment Services (which will be done during the application process in step-i).
 - b. Exception requests for each student are to be submitted individually to the Graduate School for review and approval.
 - c. If the comprehensive exam is taken in any semester beyond the first semester, the PSU cumulative GPA will be utilized. The grade of ChE 600 is acceptable for this purpose.
- (iv) Students will be permitted to take the comprehensive exam during the Summer semester (first meeting criteria 1 and 2) if they arrive at Penn State before the beginning of Summer. Students would need to be registered at PSU during the Summer for a minimum of 1 graduate credit to do so.
- (v) Students will be required to meet the [PSU Residency Requirement per GCAC-601 policy](#), at some point over a 12-month period total (regardless of the time of passing the comprehensive exam) before meeting [GCAC 608 – Final Oral Defense](#).
 - a. The residency requirement is met by being registered for a minimum of 9 graded graduate credits (ChE 600 for quality graded credits or actual graduate-level 500-courseworks for grade are permissible) during the back-to-back Fall/Spring or Spring /Fall semesters. ChE 601 or 611 cannot be used to meet the residency requirement.
 - b. Students will NOT be permitted to register for ChE 601 (post-comprehensive tuition rate) until they meet the Penn State residency requirement, in the spirit for which the policy is intended.
- (vi) The comprehensive exam taken in the previous institution cannot used to meet [GCAC 606 – Comprehensive Exam](#) requirement.