

GRADUATE STUDENT HANDBOOK

2025-26 Academic Year

Department of Chemical Engineering

University of South Carolina
Columbia, South Carolina

Revised May 2025

TABLE OF CONTENTS

INTRODUCTION	1
I. ADMISSION, ORIENTATION, AND REGISTRATION	2
ADMISSION	2
ADMISSION OF STUDENTS WITH NON-CHEMICAL ENGINEERING DEGREES	2
ORIENTATION AND REGISTRATION FOR NEW STUDENTS.....	2
REGISTRATION FOR CONTINUING STUDENTS/Z STATUS	2
THE HONOR SYSTEM	3
ACADEMIC PROGRESS.....	3
INDIVIDUAL DEVELOPMENT PLAN AND ANNUAL REVIEW	3
II. FACILITIES	5
OFFICES AND LABORATORIES	5
OFFICES, KEYS, MAILBOXES, TELEPHONES.....	5
PARKING	5
PHOTOCOPIER	5
COMPUTER ACCOUNTS	5
LIBRARY	5
RECREATION FACILITIES.....	5
III. SAFETY AND HOUSEKEEPING	6
IV. FINANCIAL SUPPORT AND ENROLLMENT	7
STIPENDS	7
RESEARCH ASSISTANTSHIPS	7
TEACHING ASSISTANTSHIPS.....	7
FELLOWSHIPS AND SCHOLARSHIPS	7
TERMINATION OF SUPPORT.....	7
TIME LIMIT ON SUPPORT.....	7
OUTSIDE WORK	7
WORK DURING UNIVERSITY RECESSES	7
VACATION POLICY.....	8
AUTHORIZED TRAVEL.....	8
ENROLLMENT.....	8
TUITION	8
STIPEND, PAYROLL AND TAXES.....	8
BENEFITS	8
V. ACADEMIC REGULATIONS AND DEGREE REQUIREMENTS	9
CHECKLISTS.....	9
COURSE REQUIREMENTS.....	9
SEMINAR ATTENDANCE	10
SELECTION OF RESEARCH ADVISOR AND PROJECT	10
ADVISORY COMMITTEE	10
ADMISSION TO CANDIDACY EXAMINATION	11
COMPREHENSIVE EXAMINATION FOR THE PH.D.	11
SUBMISSION OF RESEARCH RESULTS.....	11
PRE-DEFENSE ADVISORY COMMITTEE MEETING	12
FINAL EXAMINATION.....	12
PUBLICATION REQUIREMENTS.....	12
FINAL GRADUATE SCHOOL AND DEPARTMENT GRADUATION REQUIREMENTS.....	12
PETITION AND APPEAL PROCEDURE/COURSE VALIDATION PROCEDURE.....	12
VI. CHECKLIST FOR THE MASTER OF ENGINEERING DEGREE	14

VII. CHECKLIST FOR THE MASTER OF SCIENCE DEGREE	14
VIII. CHECKLIST FOR THE DOCTOR OF PHILOSOPHY DEGREE	15
IX. FACULTY	16
X. COURSE DESCRIPTIONS	18
XI. PROPOSAL PREPARATION GUIDELINES	20
GENERAL GUIDELINES.....	20
PROPOSAL FORMAT	20

INTRODUCTION

This handbook will acquaint you with the graduate program in Chemical Engineering at the University of South Carolina. It attempts to anticipate some of the problems you may encounter and to answer a few of the many questions that may arise. The Graduate Director will act as your advisor until your permanent advisor has been assigned to you. However, every faculty member will be pleased to discuss any matters that you have on your mind. Please feel free to drop in and talk over your specific problem(s) with us at any time.

The information in this handbook is intended to help you interpret and clarify the Degree Requirements, Academic Regulations, and Procedures of the Graduate School of the University of South Carolina as they are currently applied by the Department of Chemical Engineering. The guidelines listed here are not intended to supersede or replace the more general requirements listed in *The Graduate Bulletin of the University of South Carolina* at <https://academicbulletins.sc.edu/graduate/graduate-school/>. We welcome you to the University of South Carolina and trust that your stay with us will be both enjoyable and rewarding.

GRADUATE DIRECTOR

Dr. Andreas Heyden
Swearingen 2C17
Tel. 803-777-5025
heyden@cec.sc.edu

GRADUATE PROGRAM COORDINATOR

Marcia Rowen
Swearingen 2C04
Tel. 803-777-1261
rowen@cec.sc.edu

FINANCIAL AID/PAYROLL ADMINISTRATOR

Vernon Dorrell
Swearingen 2C32
Tel. 803-777-7284
dorrellv@email.sc.edu

CHEMICAL ENGINEERING DEPARTMENT OFFICE

Nichole Dooley
Swearingen 2C02
Tel. 803-777-4181
ND19@mailbox.sc.edu

CHEMICAL ENGINEERING INFORMATION TECHNOLOGY MANAGER

Shawn Hagan
Swearingen 2C33
Tel. 803-777-0494
hagansp@cec.sc.edu

I. ADMISSION, ORIENTATION, AND REGISTRATION

Admission

Admission to a graduate degree program in Chemical Engineering is based on the applicant's previous college work together with letters of recommendation and a personal statement. All candidates must meet general requirements for admission to the Graduate School as described in the *USC Graduate Bulletin*.

Master of Science or Master of Engineering applicants normally have a B.S. degree in Chemical Engineering from a four-year ABET-accredited engineering school. Financial aid from the Department is not usually available for students who wish to pursue M.S. or M.E. degrees.

Doctor of Philosophy applicants normally have a B.S., M.S., or ME degree in Chemical Engineering from a four-year ABET-accredited engineering school. An interview by a Chemical Engineering faculty member may be required for all applicants in determining eligibility for admission to the program with financial assistance. International students must also provide evidence of English proficiency by submitting TOEFL or IELTS score reports. International students who have earned a degree from an American college or university MAY be exempt from the TOEFL/IELTS requirement.

In a few instances, students are admitted as "non-degree" candidates. This category is used when a student does not present all of the credentials needed for admission to a degree program but can, in the opinion of the Department, benefit from our graduate program. Non-degree students may become degree candidates when their credentials are complete and they demonstrate the capability to do successful graduate work for one or more semesters.

Admission of Students With Non-Chemical Engineering Degrees

Students holding degrees in other engineering or science disciplines (B.S. or higher) may be admitted to graduate study. However, they MAY be required to complete select coursework in Chemical Engineering. Additional courses in Mathematics and Chemistry may also be required. The detailed specification of course requirements and substitutions of courses from other universities will be considered on a case-by-case basis.

Orientation and Registration for New Students

There will be an orientation session for all new graduate students at the beginning of the Fall semester.

The Graduate Director will act as your advisor until you choose a research advisor, in conjunction with the Department Chairman. After you choose a research advisor, he or she will advise you on your academic program.

New graduate students should meet with the Graduate Program Coordinator for advisement (selection of courses) and registration instructions. After advisement, students may register through www.my.sc.edu. First year graduate students will generally carry a minimum of nine credit hours of courses during the Fall semester, six credit hours each Fall and Spring semester, and three credits each Summer session thereafter in which they are receiving a stipend.

Registration for Continuing Students/Z Status

Prior to the beginning of each semester, the Graduate Program Coordinator will email registration instructions to each student. Students should then consult with their advisors and then email the Coordinator the course number(s).

The Coordinator will clear them and reply with further instructions. During the Spring and Fall semesters, students must register for a minimum of six credit hours of courses. Students must register for a minimum of three hours of ECHE courses (usually ECHE 797, 799, or 899) in each summer session for which they are in residence and are performing research leading toward a graduate degree. Each faculty member has a separate section of ECHE 797, 799, and 899; the Graduate Program coordinator will provide details.

Special Enrollment/Z Status eligibility is determined on an individual basis and must be approved by the Graduate Director, the Dean of the College, the International office, and the Graduate School. A student must have completed all required coursework except ECHE 899 (Dissertation Preparation), be working on a dissertation full-time and not have outside employment. Faculty and students should contact the Graduate Program Coordinator for additional information as to current regulations and processing. Any request for Z status must be made PRIOR to the beginning of the designated semester(s).

The Honor System

We expect all of our graduate students not only to do their own work but also to report to the appropriate faculty member any violations by others. Any graduate student guilty of a violation of these honor principles is subject to dismissal.

Academic Progress

All students must demonstrate satisfactory progress towards their degree objective. Satisfactory progress requires continuous enrollment from one semester to the next, with the exception of the summer terms. Failure to maintain continuous enrollment constitutes unsatisfactory progress. Students not making satisfactory progress may be suspended from the program and must apply for readmission. Enrollment in the summer terms is expected of all students supported on Research Assistantships.

Individual Development Plan and Annual Review

The Individual Development Plan (IDP) and Annual Review is a mechanism for creating and accomplishing both long and short term goals in pursuit of a desired career goal. To receive maximum benefit from the IDP process, it is essential that both graduate students and their faculty mentor(s) participate fully in the process. The IDP will need to be revised as circumstances change, and it is most helpful if the mentor and graduate student work together to modify the IDP. The current IDP which is to be completed by April 15 of each year is as follows:

Section I (to be completed by candidate and mentor)

A. Candidate's information

1. Date of last committee meeting (if applicable):
2. First semester and year in the USC CHE graduate program:
3. Projected semester and year of dissertation defense:
4. Project code & title of the grant(s) funding the candidate for the next year:

Section II (to be completed by candidate)

B. Mentoring Plan.

1. Should the frequency or format of regular meetings with your advisor and/or presentations to your group be modified? If so, please describe changes that you believe would be beneficial.
2. Would you like to attend a scientific meeting during the coming year? If so, identify the likely meeting and due date for abstract/application submission.
3. Are there award nominations or applications for fellowships that you should consider during the coming year? If so, identify the opportunities and their deadlines for submission.
4. Will you be conducting a search for jobs or postdocs during the coming academic year? If so, the timeline and strategy for this search should be discussed at the time that this report is completed.
5. Please note other areas where you would like more training, such as grant writing, publication writing, teaching strategies, knowledge about career opportunities, job seeking, formal scientific presentations, etc.

C. Research progress in the previous year

1. Summarize briefly in bullet style your major research accomplishments. Include a list of publications and presentations.
2. Describe in a maximum of 2 pages how these research accomplishments fit within the goals of the previous year's plan and how they relate to your thesis objectives.

D. Research plans for the upcoming year

Summarize in bullet style your primary research goals for the upcoming year. Under each goal describe its importance to your thesis and future publications and include a strategy on how you plan to accomplish that goal.

Section III (to be completed by mentor)

E. Describe the candidate's research progress and performance during the past year.

F. Does the candidate have deficiencies that could hinder progress toward obtaining their degree? If so, describe them as well as the suggested remedial action.

G. Is the student making good progress towards completing their doctoral degree?

YES MARGINAL NO

H. If it is indicated above that the student is not making good progress ('NO'), then the student's committee must meet within one month, i.e., **by latest May 15**, to discuss the student's progress and standing in the Department. If it is indicated above that the student is making 'MARGINAL' progress, the student must be re-evaluated within three months, and if progress is again 'MARGINAL', then **by latest August 15**, the student's committee must meet to discuss the student's progress and standing in the Department. The student's committee decides if a student can continue in the Ph.D. program or if the student must terminate the Ph.D. program and continue in the Master's degree program. We emphasize that the stipend of any student can be terminated or reduced at any time by the advisor if no adequate progress is being made, independent of an evaluation of the student's committee.

Section IV

This statement should be signed by both the faculty mentor and the graduate student and will serve as a yearly evaluation.

Signature of Faculty Mentor: Date:

Signature of Student: Date:

II. FACILITIES

Offices and Laboratories

The Department of Chemical Engineering occupies the first, second and third floors of the B wing and the second and third floor of the C wing of the Swearingen Engineering Center (SWR). The faculty offices are located on the second and third floor of the C wing of SWR. Some offices are also located in the Horizon Building at Assembly and Blossom Streets (see campus map).

Offices, Keys, Mailboxes, Telephones

Upon arrival, the Graduate Director will, if space is available, assign new graduate students temporary offices. The offices are located in labs or rooms set aside for graduate students. Upon selection of a research advisor, students may receive new office assignments.

Keys to enter Swearingen, graduate offices, and labs are issued by the Graduate Program Coordinator in room 2C04. Issuance of keys requires the signature, or approval by email to the Graduate Coordinator, of the faculty member in charge of the room or lab. Students whose faculty advisors have labs/offices in Horizon will instruct their students on how to obtain keys.

All full-time graduate students are assigned mailboxes. The boxes are located in room 2C31. Students should check their mailboxes regularly for university mail, homework to be graded etc. **Please be sure to keep these mailboxes free from clutter.** The departmental mailboxes should be used for official business related to your graduate activities. Use the following address for research-related business: Your Name, Chemical Engineering Department; Swearingen Engineering Center, 301 Main Street, Columbia, SC 29208.

Some offices and laboratories are equipped with telephones. In general, graduate office telephones cannot be used for chargeable long distance calls. However, some research advisors allow long distance calls to be made for research-related purposes on laboratory phones. These phones should never be used for chargeable long distance calls of a personal nature.

Parking

Students providing documentation of their enrollment as a graduate student may purchase a Graduate Student (GS) parking permit (\$130 per year). Further information about the GS permit and other parking options/regulations are at https://sc.edu/about/offices_and_divisions/parking/parking/permits/students/index.php GS permits are valid at any time in “Graduate Student” (GS), “Student” (S), and “Any Decal Parking” (AD) lots.

Photocopier

The department’s photocopier is located in the mailroom, room 2C31. The photocopier should be used only for research purposes.

Computer Accounts

The information technology manager for chemical engineering is responsible for coordinating computer accounts. Please contact Shawn Hagan at Hagansp@cec.sc.edu

Library

The library resources of the University of South Carolina are housed primarily in the Thomas Cooper Library, a seven story building located on Greene Street between the Russell House and Longstreet Theater. Detailed information is available at https://sc.edu/about/offices_and_divisions/university_libraries/index.php

Recreation Facilities

The two recreation and fitness facilities located on campus (the Blatt PE Center on Wheat Street and the Thurmond Wellness Center on the corner of Blossom and Assembly Streets) offer a wide variety of fitness activities. Students need only to present university ID cards to gain entrance into these facilities. Group Exercise programs may charge a fee. Locker rentals, laundry service, guest privilege, and family memberships are available to students, faculty, and staff for additional fees. Detailed updated information about campus recreation can be found at https://www.sc.edu/about/offices_and_divisions/campus_recreation/index.php

III. SAFETY AND HOUSEKEEPING

The Department is proud of the research and teaching facilities available in the Swearingen Engineering Center and in Horizon and urgently solicits your cooperation in their proper use and maintenance. All students are required to attend a Training session on lab safety every four years. Anyone handling chemicals MUST attend sessions ANNUALLY on biohazards and on handling of hazardous waste. And, we ask that you always observe the following general guidelines:

(a) **Safety glasses** are absolutely necessary whenever and wherever experimental work is conducted. Teaching Assistants must wear them when supervising undergraduate laboratories and are expected to insist that all students in their laboratory sections do so as well. Your research advisor will provide safety glasses.

(b) Appropriate PPE must be worn at all times in the laboratories. No one is permitted in the Departmental laboratories or stockrooms without shoes or in shorts. Open-toed sandals are also not permitted in any laboratory. Safety gloves should not be worn when touching doorknobs or handling potentially shared devices such as hand trucks, dollies, gas cylinders, liquid nitrogen etc. Teaching Assistants are expected to enforce this policy in their undergraduate laboratory sections.

(c) Before leaving any experiment to operate unattended overnight, you must first make sure that it does not constitute a possible fire or flood hazard. You must clearly post visible information on the door listing a phone number to be contacted for emergencies. Specifically, if flammable solvents are involved, they should be left in a closed hood. If this is not possible, check all joints to see that they are well lubricated and vapor tight. If running water is involved, please make sure that all tubing is in good condition, that all connections are tight (preferably wired) and that all connecting troughs and/or sinks are free of any debris (corks, Kimwipes, etc.) which could clog the drain. Be sure to check with your advisor for approval first.

(d) All refrigerators in laboratories must be clearly marked “for chemicals only.” No food may be stored in laboratory refrigerators.

(e) No one will be allowed to handle or work with radioactive isotopes or around potentially dangerous sources of radiation, e.g., X-ray, microwave, laser, until he has been thoroughly instructed by the faculty member in charge on the proper safety precautions and procedures to be followed. All such workers MUST also complete the USC Environmental Health and Safety Radiation Safety Training and/or laser safety training.

(f) The faculty member in charge of a laboratory and the Department Safety Coordinator (Carol Stork, cell phone 447-4312) should be informed immediately of any safety hazards or accidents. Any complaints regarding potential safety hazards and any safety suggestions will be treated seriously and greatly appreciated.

***To summon emergency help, call the University Police at 7-9111. For emergency medical treatment, proceed to Thompson Student Health Center (behind Russell House, 7-3175). If they are closed, proceed to the nearest hospital (PRISMA Health Baptist) for care. Be sure to contact the Department Chairman and Safety Coordinator concerning the accident.**

IV. FINANCIAL SUPPORT AND ENROLLMENT

Stipends

Almost all graduate students admitted to the Ph.D. program receive financial support from funds administered by the University. Financial support may be in the form of research assistantships, fellowships, or scholarships.

M.S., M.E., and off-campus students do not normally receive financial support.

Research Assistantships

Research assistantships are awarded on the basis of good academic standing, experience, and interest in the research problems for which assistantship funds are available. Research assistantships are awarded on the recommendation of the individual faculty member responsible for the funds involved. The duties and hours are those set by the supervising faculty member. In addition, for Ph.D. students, the department expects five (maximum 10) hours per week of teaching assistant-type work such as paper grading or laboratory help.

Students receiving departmental assistantships are expected to pursue their degree objective with all due vigor. This specifically excludes holding outside employment. Recipients of assistantships will be reviewed each semester to determine whether they have made satisfactory progress in the preceding semester. Renewal and the level of the assistantship is contingent upon both an exhibition of satisfactory academic progress (as defined in section I and *The Graduate Bulletin*) and continuing availability of funds. Ph.D. students will be supported for no more than five years.

Teaching Assistantships

Half-time teaching assistants (TA) normally devote up to 20 hours per week toward the supervision and operation of our undergraduate unit operations laboratory and/or grading hour quizzes and homework, as required by the faculty member teaching the course. In addition, TAs may be required to attend briefing sessions, hold office hours and may also be required to attend the lectures. Attendance at these briefing sessions and course lectures is an essential part of TA duties.

Fellowships and Scholarships

Fellowships and scholarships are sometimes available from industrial, government, and private sources. These may be allocated by the Department, they may be awarded competitively on an inter-departmental basis by the University, or they may be awarded through national competitions. The Department will attempt to inform you of all such support available and will be glad to assist qualified persons in applying.

Termination of Support

After an assistantship or fellowship has been awarded, you may normally expect continued support during the period of your graduate study. This support is contingent upon availability of funds and satisfactory performance of the duties of the assistantship, normal progress towards a degree, and satisfactory academic performance as defined by the requirements outlined in section I and *The Graduate Bulletin*. Stipends may be reduced or suspended for students who are not making satisfactory or timely progress towards fulfillment of their degree requirements.

Time Limit on Support

It is the policy of the Department that, except in unusual circumstances, no graduate student shall be supported on teaching or research assistantships longer than five years for a Ph.D. degree.

Outside Work

A student assistant is expected to devote full time to assistantship duties and graduate studies. Outside employment is, therefore, not allowed.

Work During University Recesses

The duties of Research Assistants continue throughout the year on all days that the University is open for regular business. The duties of Teaching Assistants normally begin with the general meeting of teaching assistants at the start of each term and end when laboratories have been checked out and the final examination in the course has been graded.

Vacation Policy

Students on research assistantships must work out schedules and personal leave time with their research advisor. The student's

research advisor should approve all personal leave absences. Extended absences (more than five working days) must be requested and approved in writing.

Authorized Travel

Students may have the opportunity to travel related to their research and financially supported by the Department and/or their advisors. Travel Grants are available from the Graduate School; complete information and requirements are at https://sc.edu/study/colleges_schools/graduate_school/tuition-funding/travel_grants/index.php Students should carefully read the directions and restrictions. Please see the Graduate Program Coordinator for further information. Travel Authorization forms (TA's) and Travel Reimbursement Vouchers (TRV's) are available in the Chemical Engineering office (Swearingen 2C02). The Administrative Coordinator can assist in the preparation of these documents.

Enrollment

All graduate students must maintain continuous enrollment while they pursue a degree in the department. Students appointed as research or teaching assistants must enroll for a minimum of six credit hours each Fall and Spring semester and three credit hours each Summer term. Students who are not supported on assistantships or are part-time students must also maintain continuous enrollment of at least three credit hours each Fall and Spring semester and one hour each Summer term.

Tuition

All Assistantship appointments entitle students to the in-state resident rate of tuition. In general, advisor research funds (supplemented by Departmental funds if available) are used to pay the tuition for doctoral students appointed as Graduate Research Assistants (GRAs). Paperwork appointing a student as a GRA should be completed prior to registration. Students should ensure that all other enrollment issues (immigration paperwork, original transcripts, health insurance enrollment) are resolved prior to registration to minimize problems that may prevent enrollment. Please see the Graduate Program Coordinator if problems arise with respect to GRA appointment and tuition payment.

Stipend, Payroll and Taxes

Graduate assistant stipends are paid twice per month by direct deposit, on the 15th and the last day of each month. If either of these days falls on a Saturday or Sunday, pay is deposited the preceding Friday. Please note that earnings for the first half of the month will be paid at the end of the month, and earnings for the second half of the month will be paid the following month on the 15th. Arrangements must be made to deposit checks directly to an individual's bank account; you may sign up for direct deposit at www.my.sc.edu in the Payroll section. Federal and state income taxes will be deducted from these checks. All students must complete an I-9 form before being placed on the payroll. This form can be obtained from the Departmental business manager or the Graduate Program Coordinator. A W-4 form must also be completed to establish the level of federal and state tax withholding. The IRS considers income from assistantships to be taxable, but the tuition remission is not taxable.

Benefits

All full-time graduate students (enrolled in nine or more credit hours), all Graduate Assistants, and all international students are required to have health insurance coverage. Graduate students receiving TA or GA support qualify for fully subsidized health insurance. Students not receiving TA or GA support may purchase coverage in the University's health insurance plan. The premium for this coverage will be included on the tuition bill each semester. Payments can be prorated and automatically deducted from stipend paychecks. More information about the Student Health Insurance Plan can be found at the following link: <http://www.sa.sc.edu/shs/billing/insurance/>

Alternatively, students may provide evidence of coverage by another comparable health insurance plan. Information about waiving out can be found at the following link: <http://www.sa.sc.edu/shs/billing/insurance/>

V. ACADEMIC REGULATIONS AND DEGREE REQUIREMENTS

Checklists

Checklists that outline the degree requirements and timetable for all graduate degrees in Chemical Engineering are given in Sections VI, VII, and VIII. This section provides more detailed descriptions of degree requirements.

Course Requirements

For the **Master of Engineering** and the **Master of Science** degrees, four specific core courses are required:

ECHE 700	Chemical Process Analysis
ECHE 710	Advanced Chemical Engineering Thermodynamics
ECHE 720	Advanced Fluid Flow Analysis
ECHE 722	Advanced Mass Transfer

For the **Master of Engineering** degree, six additional 3-credit lecture courses are required. Two of these must be from Chemical Engineering, and the remaining four may be from Business, Engineering, Chemistry, Mathematics, Statistics, Physics, Biology, Medicine, etc. Directed Research (ECHE 797) may substitute for up to two of the remaining four courses. The Graduate Director or Advisor specifies the Program of Study (showing a minimum of 30 credit hours) after discussion with the student.

For the **Master of Science** degree, four additional 3-credit lecture courses, and a maximum of six hours of Thesis Preparation (ECHE 799) are required. Two of the four courses must be from Chemical Engineering and the remaining two may be from Engineering, Chemistry, Mathematics, Statistics, Physics, Biology, Medicine, etc. Directed Research (ECHE 797) cannot substitute for any of these courses. The Research Advisor specifies the Program of Study (showing a minimum of 30 credit hours) after discussion with the student and the Thesis Committee.

For the **Doctor of Philosophy** degree, four specific core courses are required:

ECHE 700	Chemical Process Analysis
ECHE 710	Advanced Chemical Engineering Thermodynamics
ECHE 720	Advanced Fluid Flow Analysis
ECHE 722	Advanced Mass Transfer

For students entering the **Doctor of Philosophy** program with a Bachelor of Science degree in Chemical Engineering, the Program of Study must show a minimum of 60 credit hours, including at least 8 3-credit lecture courses (24 credit hours, described below), no more than 6 credit hours of Directed Research (ECHE 797), and 12-30 credit hours of Dissertation Preparation (ECHE 899). Students may, with their advisor's approval, substitute up to 18 hours of electives for ECHE 899. **Note: a MINIMUM of 12 hours of ECHE 899 is required by the Graduate School.** Students will generally accumulate additional credits of ECHE 899 to maintain full-time student status, but these should not be included on the Program of Study. The eight required lecture courses (24 credit hours) include the four core courses and four additional lecture courses. The four additional courses may be from Engineering, Chemistry, Mathematics, Statistics, Physics, Biology, Medicine, etc., upon approval of the student's Dissertation Committee and the Graduate Director. No more than two courses below the 700 level may appear on the Program of Study. Students must also register once for one credit hour of ECHE 798 Seminar, which is offered each Spring semester.

For students entering the **Doctor of Philosophy** program with a Master of Science degree in Chemical Engineering equivalent to that awarded at the University of South Carolina, the Program of Study must show a minimum of 30 credit hours beyond the M.S. degree, including up to 24 credit hours of Dissertation Preparation (ECHE 899) or additional lecture courses in place of ECHE 899 and six hours of ECHE 797. Any additional lecture courses may be from Engineering, Chemistry, Mathematics, Statistics, Physics, Biology, Medicine, etc., upon approval of the student's Dissertation Committee and the Graduate Director. No more than two courses below the 700 level may appear on the Program of Study, including courses taken in the prior M.S. degree program.

Note: Students who enter with a Master's degree may, AFTER they have passed the Admission to Candidacy exam, request that the Department approve the Master's degree as equivalent to ours. The student should send an email request to the Graduate Director and the Department Chair, copying the Graduate Program Coordinator. A copy of the student's MS transcript should be attached.

The overall Program of Study, including courses taken in the prior M.S. degree program, must include the four required core

courses for the Ph.D. degree and the one credit ECHE 798 Seminar. Courses taken during the prior M.S. degree program may be used to fulfill these requirements. Students must submit petitions to the Graduate Director, supported by appropriate documentation, to seek approval for substitution of prior course work for any of the four required core courses.

Ph.D. students are required to maintain a graduate GPA of at least 3.0 at every point in their graduate career. No foreign language is required for any graduate degree in Chemical Engineering.

Students holding degrees in other engineering or science disciplines may be admitted to Chemical Engineering graduate studies after completing required course work in Chemical Engineering at the undergraduate level.

Additional courses in Mathematics and Chemistry may also be required for all these degrees. The detailed specification of course requirements and substitutions of courses from other universities will be considered on a case-by-case basis by the Graduate Director in consultation with other faculty in the department.

Seminar Attendance

The Department sponsors frequent seminars. All graduate students are *required* to attend these seminars. Notice of upcoming seminars will be posted, put in mailboxes, and distributed electronically. Failure to attend seminars may result in an evaluation indicating unsatisfactory progress, and hence revocation of financial support.

Selection of Research Advisor and Project

The choice of a research advisor and project is the most important decision of your graduate program. In order to ensure that you have as much information as possible to make your choice, we have formalized the interviewing and selection process. This process may include presentations by the faculty and interviews with the entire faculty. The research interest areas of the faculty are outlined in Section IX below. You may consider any research area that is of interest to you. Many faculty members have research programs that cover more than one area. You are encouraged to explore all possibilities before you solidify your choice of general research area and a specific research advisor.

Before selecting a research advisor, you may be asked to listen to presentations and interview every member of the Chemical Engineering faculty. To facilitate the interviewing process, you will be provided with an interview form (Advisor Selection letter). You should take this form with you to each of your faculty interviews so that each faculty member can sign and date the form. You should then present the completed form to the Graduate Program Coordinator.

Students entering the graduate program in the Fall semester must present the completed form indicating three ranked choices to the Graduate Director by the deadline indicated on the Advisor Selection form. Students entering in the Spring must do likewise. The Department Chairman and Graduate Director will then match the students to advisors, taking into account the interests of the student as well as the number of openings in each professor's research program.

Advisory Committee

After a doctoral student passes the Admission to Candidacy Examination, and before the end of the second Spring semester in which the student is enrolled (students first enrolled in a Spring semester must do so before the beginning of their second Fall semester), said student should select an advisory research committee of no fewer than four members, including at least three members from Chemical Engineering and one member from a department other than Chemical Engineering. The student should notify the Graduate Program Coordinator via email of the Committee members; the Coordinator will prepare and process the necessary paperwork. Please note that The Graduate School permits only one outside member on a Doctoral Committee. This outside member is usually a faculty member in another Department at USC. If a student and his advisor wish to have as the outside member anyone other than a USC faculty member, the Graduate Program Coordinator should be contacted for instructions. The proposed outside member should submit a CV to the Graduate Program Coordinator, who will process the request for a Term Appointment to the USC Graduate Faculty for this individual. The research advisor is the chair of the advisory committee. The Department Chair is an ex-officio member of all Doctoral committees and should be included on all paperwork. The advisory committee should approve the candidate's project and program of study and review periodic progress reports prepared by the student. Upon completion of the project, the Research Advisor must confirm that work for the degree is complete in a memorandum to the Graduate Director.

The M.S. student must select a research project and an advisory committee of no fewer than three members from Chemical Engineering by the end of the first year. In addition to the three members from the Department, a committee member from outside the Department is permitted but not required. The Department Chair is an ex officio member of every M.S. advisory committee and should be included on all paperwork in addition to the members specified above.

Admission To Candidacy Examination

The Admission to Candidacy (AtC) Examination is offered annually, and is in two parts. The first part, usually administered in December or January, consists of an oral exam covering chemical engineering fundamentals such as thermodynamics, fluid mechanics, mass and energy balances, and chemical kinetics. In some instances, the chemical engineering faculty may ask a student to repeat part or all of the first oral exam a few days after the first attempt.

The second portion of the exam is held in August and consists of students' presenting summaries of their research to date. These oral presentations are to be approximately fifteen minutes in length; students should submit an abstract of the research presentation at least two days in advance of the exam.

Students are expected to take the AtC Exam at the first offering following enrollment at the graduate level. Students with previous degrees that are not in Chemical Engineering are expected to take the AtC Exam at the first offering following completion of required remedial work.

Based on performance of the AtC Exam, a student may pass, pass conditionally, or fail the exam. Passing or conditionally passing the first part of the AtC Exam is a requirement for admission to the second part of the exam. Students who pass both parts of the AtC Exam (and submit a completed Advisory Committee form and Program of Study) are admitted to candidacy for the Ph.D. degree. Students who earn a conditional pass may be required to complete remedial coursework or other assignments as additional degree requirements. Upon completion of these requirements, the student may be admitted to candidacy for the Ph.D. degree. Students who fail any part of the AtC Exam are reclassified as M.S. students. Reclassified M.S. students are required to identify an advisor and are provided with a reduced stipend for a period of up to 21 months (from the original date of their admission into the graduate program) to complete their M.S. degree. The reduced stipend is determined by the advisor. Reclassified M.S. students are allowed to take the AtC Exam at the next opportunity if they are in good academic standing at that time. At the request of the M.S. student, and with the approval of the student's advisor, both parts of the AtC exam of a reclassified M.S. student can occur at the time of the M.S. defense. In this case, all chemical engineering faculty members shall be informed of the AtC exam date, time and location, and all chemical engineering faculty members are invited to attend this exam and act as examiners. The outcome of this alternate AtC exam is determined by the attending chemical engineering faculty members and is based on the research presentation and a determination of a good knowledge in the fundamentals of chemical engineering such as thermodynamics, fluid mechanics, mass and energy balances, and chemical kinetics. If they pass the exam at that time, they can apply, with the approval of their advisor, to the graduate committee for readmission in the Ph.D. program. No student is allowed to take the AtC Exam more than twice.

Comprehensive Examination for the Ph.D.

The Comprehensive Examination for the Ph.D. degree consists of a written research proposal presented to and defended orally before the student's advisory committee. The proposal shall describe an original plan of research suitable for submission to a funding agency. The proposal may describe research to be completed for the student's dissertation. The written proposal must conform to established guidelines outlined in the appendix.

Note that part of the proposal is a one-page project summary, written according to the requirements of either the National Science Foundation or the National Institutes of Health. The proposal must be submitted to and approved by all committee members before the student may schedule the oral portion of the comprehensive exam. All Chemical Engineering faculty are welcome to attend the presentation. The student should contact the Graduate Program Coordinator in advance of the exam; she will provide the student with the necessary paperwork to be signed after the exam by the Advisory Committee and the Graduate Director. This signed paperwork should be returned to the Coordinator for processing.

The written proposal must be completed and given to the advisory committee by the end of the student's fourth semester (by May 15, or October 15, depending on date of enrollment). The candidate must demonstrate satisfactory progress towards the oral portion of the Comprehensive Exam by May 22 (or October 22 if first enrolled in Spring semester). Failure to schedule by May 22 (or October 22 if first enrolled in Spring semester) the Comprehensive Exam and complete by August 31 (or January 15 if first enrolled in Spring semester) indicates unsatisfactory progress in the PhD program and results in reclassification of the student to an M.S. student with concomitant reduction of the candidate's stipend to the MS level. The reduced stipend is determined by the advisor.

Submission of Research Results/Graduate Student Symposium

The results of each student's research must be communicated to the engineering community-at-large. During the Spring semester of their third year enrolled, Ph.D. students are required to give a presentation at the Graduate Student Symposium. M.S. and Ph.D. students are required to submit their research results in the form of technical papers to peer-reviewed journals before graduation. It is recommended that these papers be prepared before the thesis or dissertation is completed and defended. The Department requires that M.S. students submit one paper to a reputable journal for publication prior to graduation, while

Ph.D. students must submit at least three papers, on at least TWO of which the student is listed as first author.

Pre-Defense Advisory Committee Meeting

Six months prior to the Final Examination, each student should convene a meeting of his Advisory Committee to review research progress and discuss milestones and plans for completing his dissertation research. The outcome of this meeting must be reported in writing to the Graduate Director. Please contact the Graduate Program Coordinator IN ADVANCE for the necessary form to be completed and signed.

Final Examination

The student's Advisory (Doctoral or Master's) Committee conducts the Final Examination (Dissertation or Thesis Defense). For Ph.D. students, this exam serves as the Dissertation Examination. For M.S. students, it serves as the Comprehensive Examination. M.E. students are also required to complete a Comprehensive Exam, the content and process to be determined by the student's advisor, usually the Graduate Director.

The student should contact all members of the Advisory Committee to establish an acceptable time, date, and place for the examination. The Graduate Program Coordinator should next be informed of the date, time, and preferred location of the defense and the title of the thesis or dissertation. The Coordinator will prepare the necessary paperwork to the student and will notify the Department faculty, research associates, staff and graduate students of the defense. The student should also send, to the Coordinator, a two-paragraph abstract summarizing the content of the thesis or dissertation. Copies of the thesis or dissertation should be provided to all members of the Advisory Committee well before the time scheduled for the examination. Upon successful completion of the Final Examination, the members of the Advisory Committee sign the Dissertation Defense sheet and a memorandum, indicating the student has completed this portion of the requirements for the M.S. or Ph.D. degree. These documents will be returned to the student, who should immediately return them to the Graduate Program Coordinator, who will process them.

Publication Requirements

The Department requires that all Ph.D. candidates submit, prior to clearance for graduation, at least three articles to peer-reviewed journals. The candidate must be first author on at least TWO of the articles. A copy of the FIRST PAGE ONLY of PUBLISHED ARTICLES should be submitted to the Graduate Program Coordinator. Copies of submission letters and/or acceptance letters may be submitted; copies should be on letterhead and signed appropriately. Publication/submission delays must be approved in writing by the Department Chair upon request by the student's advisor. The advisor should specify the estimated date of submission/publication.

Final Graduate School and Department Graduation Requirements

Degree applications for all degrees must be filed early in the semester preceding graduation; deadlines are determined by the Graduate School and will be posted in the Department. Degree applications may be filed prior to submission of theses or dissertations and the Final Examination. The Graduate Program Coordinator should be provided with a copy of the student's Graduation Application. There is no filing fee, and graduation in that semester is not mandatory by the Graduate School. However, a student who does not graduate after applying must reapply in the appropriate semester. Final theses and dissertations must be submitted electronically to the Graduate School; candidates for degrees must meet the deadlines and fulfill the formatting requirements set by the Graduate School. Detailed information may be found at

https://sc.edu/study/colleges_schools/graduate_school/graduate-studies/thesis_and_dissertation/index.php

Please also go to https://sc.edu/study/colleges_schools/graduate_school/graduate-studies/forms_library/index.php

The Survey of Earned Doctorates, noted there on Page 2, MUST be completed in order to receive Graduate School clearance. In addition, the Chemical Engineering Graduate Exit Survey should be completed. The Chemical Engineering Graduate Exit Survey can be accessed at: <https://forms.office.com/r/nJM3Qdi73r>

Petition and Appeal Procedure/Course Validation Procedure

The Departmental Graduate Committee functions as a petition and appeal committee for graduate students requesting relief from a departmental academic regulation. The Committee consists of the Graduate Director, the Department Chair, the petitioning student's advisor, and, at the request of the Graduate Director, other faculty members of the Departmental Graduate Committee (usually two other tenure track faculty members). Students seeking relief from a departmental academic regulation must first consult with the Graduate Director (for students not yet admitted to degree candidacy) or their Research Advisor and Advisory Committee. The Graduate Committee will consider petitions forwarded from either the Graduate Director or from the student's Advisory Committee. The Graduate Committee only considers petitions coming from the Graduate Director or Advisory Committees.

If the student's request receives an unfavorable recommendation from the Graduate Director or the student's Advisory Committee, the student may appeal in writing directly to the Graduate Committee. Unsatisfactory progress in meeting degree requirements may result in loss of financial support and/or disqualification from a degree program. In cases in which the departmental regulations permit remedial action, and if the remedial action brings the student into compliance with the regulations, then the Graduate Committee will normally consider a reinstatement of financial support and/or qualification for a degree program. The student may also regain lost status by favorable action on a new application for admission.

If the student is unable to achieve a satisfactory resolution to an academic issue within the department, following departmental procedures, the student should submit a written request for consideration by the CEC Graduate Grievances, Appeals, and Petitions Committee. The form to be used and instructions thereto is at https://sc.edu/study/colleges_schools/graduate_school/documents/g-gap.pdf

Policies

Courses are valid for six years in a Master's degree program and ten years in a doctoral program. Only USC courses on a Program of Study may be revalidated. There is no provision for revalidating courses from other institutions.

Each Department will determine which of its courses are appropriate for the revalidation process. Two factors to consider are stability of course content and student content retention. If the course content has substantially changed since the student's enrollment, revalidation should not be undertaken. The revalidation examination should confirm that the student's retention of course content is comparable to that of current students who have just completed the course.

Procedure

1. Student should complete section 1 of the "Permit For Course Revalidation Examination" available on the Graduate School website at https://www.sc.edu/study/colleges_schools/graduate_school/documents/pre.pdf The form is intended for use with only one course.) (List course designation and number.) (Example: ENGL 738)
2. Verify with the Department Chairman or Graduate Director of the Department offering the course that the requested course may be revalidated. If so, the authorized examiner, a regular faculty member who currently teaches this course, will be identified.
3. Obtain assigned advisor's approval signature.
4. Pay course revalidation fee (\$25.00 per credit hour) in the Bursar's office, 1244 Blossom Street, First Floor.
5. Present fee receipt and Permit For Revalidation Examination to the Graduate Director for approval signature.
6. Present approved form to course examiner to schedule and complete examination.
7. Course examiner performs and grades exam, then forwards the endorsed Permit for Revalidation Examination form to the Dean of the Graduate School.

VI. CHECKLIST FOR THE MASTER OF ENGINEERING DEGREE

Steps	Timing	Responsibility
1. Initial advisement by Graduate Director	Before registration for first semester	Student
2. File Program of Study	By end of first year	Student – see Coordinator
3. Complete course requirements and ME Comprehensive Exam	As soon as possible (normally 3 or 4 semesters)	Student
4. File M.E. Degree Application at the Graduate School	Early in the semester prior to date of graduation	Student – see Coordinator
5. Certify completion of degree requirements	Not less than ten days prior to date of graduation	Graduate Director
6. Receive Degree	Commencement	USC Board of Trustees

VII. CHECKLIST FOR THE MASTER OF SCIENCE DEGREE

Steps	Timing	Responsibility
1. Initial advisement by Graduate Director	Before registration for first semester	Student
2. Select Research Advisor	During first semester (10/1 or 2/15 deadline)	Student, Faculty and Graduate Director
3. File Program of Study	By end of first year	Student-see Coordinator
4. Submit thesis proposal to Graduate Director	During first year	Student
5. Complete course requirements	As soon as possible (normally 2 or 3 semesters)	Student
6. Submit one paper to a technical journal	Before clearance for graduation	Student
7. Schedule Defense and Defend Thesis	See University Calendar	Student
8. File M.S. Degree Application at the Graduate School	Early in the semester prior to date of graduation	Student-see Coordinator
9. Submit final thesis draft to the Graduate School	See University Calendar	Student
10. Certify completion of degree requirements	Not less than ten days prior to date of graduation	Research Advisor and Graduate Director
11. Receive Degree	Commencement	USC Board of Trustees

VIII. CHECKLIST FOR THE DOCTOR OF PHILOSOPHY DEGREE

Steps	Timing	Responsibility
1. Initial advisement by Graduate Director and Graduate Coordinator	Before registration for first semester	Student
2. Select Research Advisor	During first semester (10/1 or 2/15 deadline)	Student, Faculty, Graduate Director, Department Chair
3. Admission to Candidacy Examination	Between Fall and Spring semesters for the theory section. For the research section, before the beginning of the Fall semester following the theory section.	Student (administered by Faculty)
4. Select Ph.D. Advisory Committee and submit Committee form	During second, third, or fourth major semester	Student and Research Advisor-see Coordinator
5. File Program of Study	During second, third or fourth major Semester	Student and Advisor- see Coordinator
6.Recommend Admission to Ph.D. Candidacy	Upon successful completion of steps 3, 4, and 5.	Graduate Director
7. Pass Comprehensive Examination	Before the beginning of the fifth major semester	Student, Advisory Committee, Graduate Director
8. Complete courses in Program of Study	As soon as possible (normally done in 2 or 3 years)	Student and Advisor
9. Submit a minimum of three papers to technical journals. On at least TWO of these, the student must be listed as first author.	Before clearance for graduation	Student
10. Convene Pre-Defense Advisory Committee meeting	Six months prior to proposed date of final examination (defense).	Student
11. Write dissertation	As soon as possible	Student
12. File Ph.D. Degree Application at the Graduate School. Check that records of all formal degree requirements are in order	Early in the semester prior to date of graduation	Student-see Coordinator
13. Submit first draft of dissertation to Research Advisor	About ten weeks before the dissertation is due in Graduate School Office	Student
14. Schedule dissertation defense.	1 month	Student-see Coordinator
15. Announce & distribute abstract of defense dissertation	Allow at least two weeks for committee approval	Student-see Coordinator
16. Defend dissertation at Final Examination; notify Graduate Director of outcome.	At least thirty days prior to date of graduation and in compliance with Graduate School deadlines	Student and Advisory Committee
17. Make necessary changes in dissertation; obtain committee signature on dissertation title pages.	Immediately after dissertation defense.	Student
18. File dissertation electronically according to Graduate School instructions. Order hard copies for advisor if desired. Pay all final fees.	See University calendar.	Student-see Coordinator
19. Certify completion of degree requirements.	Not less than ten days prior to date of graduation	Graduate Director
20. Receive Degree	Commencement	USC Board of Trustees

IX. FACULTY ADVISORS

- Melis Duyar** Associate Professor, PhD Columbia University, 2015
Heterogeneous catalysis, rational catalyst design, carbon capture and utilization, plastics upcycling
- Edward P. Gatzke** Associate Professor, Ph.D. University of Delaware, 2000.
Chemical process control and optimization, numerical methods and parallel computing, dynamic simulation of complex systems, particulate processing system operation.
- Andreas Heyden** MCEC Distinguished Professor, Ph.D., Hamburg University of Technology, Germany, 2005
Graduate Director
Computational (electro-)catalysis, computational nanoscience, data science
- Golareh Jalilvand** Assistant Professor, Ph.D. University of Central Florida, 2020
Structural materials; batteries; micro- and nano-fabrication; flexible and wearable energy storage systems
- Jochen Lauterbach** Professor and COEE Chair to the Generation of Electricity, Ph.D., Free University of Berlin, Germany, 1994
Spectroscopy, heterogeneous catalysis, combinatorial catalysis, CO₂ utilization
- Michael A. Matthews** Professor and Associate Dean, Research and Graduate Education, Ph.D. Texas A&M University, 1986.
Thermodynamics and transport properties; supercritical fluids; biomaterials processing; green chemistry and engineering; hydrogen storage and generation.
- William Mustain** Director of CIBI, Professor, Ph.D. Illinois Institute of Technology, 2006
Design, characterization and implementation of electroactive materials in electrochemical systems
- Zhenmeng Peng** Professor, Ph.D. University of Rochester, 2010
Catalyst materials, chemical and electrochemical reactions; energy storage; Electrochemical engineering
- Branko N. Popov** Carolina Distinguished Professor, Ph.D. University of Zagreb, Croatia, 1972
Materials characterization and properties; corrosion engineering; electrodeposition of metal and alloys from aqueous solution and molten salts; application of electrochemical techniques to electrochemical systems and batteries.
- John Regalbuto** Professor and COEE Chair in Catalysis for Renewable Fuels, Ph.D. University of Notre Dame, 1986.
Catalyst preparation & characterization, adsorption theory, reaction kinetics.
- James A. Ritter** Carolina Distinguished Professor, Ph.D. State University of New York at Buffalo, 1989
Cyclic adsorption processes for gas separation, purification and energy storage; characterization of commercial and developmental adsorbents for adsorptive separation and purification; measurement of equilibrium and transport properties of adsorbate-adsorbent gas pairs.
- Monirosadat Sadati** Assistant Professor, Ph.D. ETH Zurich, Switzerland, 2012
Soft-matter, polymers, active materials, liquid crystals, 3D printing, microfluidics, and rheology.
- Srivatch Shimpalee** Research Professor, Ph.D. University of South Carolina, 2001
Multi-scale and multi-dimensional modeling of transport phenomena in electrochemical

systems and the acquisition of experimental data associated with these systems.

Ralph E. White

Westinghouse Distinguished Scientist, Professor, Ph.D. University of California at Berkeley, 1977

Mathematical modeling and the acquisition of experimental data associated with batteries, fuel cells, electrodeposition, corrosion, and the production of chemicals by electrochemical means.

Christopher T. Williams

Professor, Ph.D. Purdue University, 1997

Chair

Heterogeneous catalysis, enantioselective catalysis, adsorption at liquid- and gas-solid interfaces, nanostructured catalyst design, surface spectroscopy, chemical reaction engineering, electrochemical surface science.

Hui Yang

Assistant Professor, PhD Institute of Chemistry Chinese Academy of Sciences, China, 2016

Materials design, electrochemical energy storage, sustainability/ photocatalysis/CO₂ capture and utilization, charge transfer mechanisms and kinetics.

X. COURSE DESCRIPTIONS

700 Chemical Process Analysis (3) Quantitative analysis of industrial chemical operations. Equilibrium relations, material and energy balances, and reaction kinetics principles are used to analyze a variety of chemical processes and systems.

709 Selected Topics in Industrial Stoichiometry (3) Special topics in industrial stoichiometry with emphasis on current research.

710 Advanced Chemical Engineering Thermodynamics (3) (Prereq: ECHE 311) Mass, energy, and entropy balance analysis of complex systems; evaluation of thermodynamic property changes of pure materials; solution thermodynamics of single-phase multicomponent systems; phase and chemical reaction equilibrium.

719 Selected Topics in Chemical Engineering Thermodynamics (3) Special topics in chemical engineering thermodynamics with emphasis on current research.

720 Advanced Fluid Flow Analysis (3) (Prereq: ENGR 360 and MATH 242) Theory and application of fluid flow phenomena; momentum equations, conformal mapping, empirical methods, boundary layers, dimensional analysis.

721 Advanced Heat Flow Analysis (3) (Prereq: ECHE 321 and ECHE 720) Theory and application of heat flow phenomena; classical techniques and finite-difference numerical methods; conduction, convection, radiation, and boiling.

722 Advanced Mass Transfer (3) (Prereq or coreq: ECHE 720) Diffusive and convective mass transfer. Applications of the Stefan-Maxwell equations, prediction of diffusion coefficients, convective mass transport, correlations for mass transfer coefficients, and combined mass transfer and reaction modeling.

725 Rheology (3) Rheological characteristics of viscous, elastic, viscoelastic and plastic substances; non-Newtonian fluid flow, viscometry, and rheogoniometry; rheological equations of state; engineering applications.

728 Selected Topics in Fluid Mechanics (3) Special topics in fluid mechanics with emphasis on current research.

729 Selected Topics in Heat and Mass Transfer (3) Special topics in heat and mass transfer with emphasis on current research.

730 Chemical Reactor Design (3) Optimum temperature sequencing. Modeling of non-ideal reactors. Theories of catalysis with emphasis on the rate of diffusion. Interpretation of experimental catalytic data and use of these data in reactor design.

735 Heterogeneous Catalysis – Fundamentals (3) Fundamentals of heterogeneous catalysis, with emphasis on computational catalysis.

736 Heterogeneous Catalysis – Synthesis, Characterization and Evaluation (3) Catalyst synthesis methods' experimental characterization approaches, correlating synthesis/characterization with catalytic performance.

737 Industrial Catalysis (3) History of catalysis; industrial applications of catalysis; development of catalytic reactions from lab to pilot to production scale.

739 Selected Topics in Kinetics and Reactor Design (3) Special topics in kinetics and reactor design with emphasis on current research.

740 Distillation (3) Analytical, shortcut, and computer techniques for plate contacting of multicomponent systems. Review of binary separations. V-L-E models, azeotropics and extractive distillation, effects of non-key components, computational schemes, and convergence criteria.

741 Liquid-Liquid Extraction (3) Principles of modeling liquid-liquid extraction cascades. Evaluation of L-L-E, ternary systems, design applications for hydrometallurgical systems, interlinked cascade structures for multiple solute systems, efficiency of process equipment, and synergism.

742 Adsorption Fundamentals and Processes (3) Advanced principles of adsorption and adsorption processes including adsorbents, thermodynamics, kinetics, fixed bed adsorption and cyclic adsorption processes.

- 749 Selected Topics in Separations (3)** Special topics in separations with emphasis on current research.
- 750 Process Dynamics and Control (3)** (Prereq: ECHE 550) Advanced topics in chemical process dynamics and control. Multivariate analysis, system identification, sampling, optimal process control.
- 759 Selected Topics in Process Control (3)** Special topics in process control with emphasis on current research.
- 769 Selected Topics in Chemical Engineering Design (3)** Special topics in chemical engineering design with emphasis on current research.
- 770 Electrochemical Engineering (3)** Electrochemical engineering principles developed from thermodynamic, kinetic, mass transfer, and potential theory. Numerical analysis and design of electrochemical systems. Statistical analysis of experimental data and industrial experimental designs.
- 771 Corrosion Engineering (3)** Corrosion engineering principles developed from thermodynamic, kinetic, mass transfer, and potential theory. Numerical analysis of corroding systems, statistical analysis of experimental data, and industrial experimental designs.
- 772 Principles of Polymer Systems (3)** Theory and applications of polymer systems. Structure, physical properties, rheological, and mechanical behavior of polymers. Polymerization reactions and industrial polymerization processes. Fabrication techniques.
- 789 Selected Topics in Chemical Engineering (3)** Approved for special topic offerings.
- 797 Research (1-6)** Individual research to be arranged with instructor.
- 798 Graduate Seminar in Chemical Engineering (1-2)** Seminar
- 799 Thesis Preparation (1-12)** To be arranged by candidates for the master's degree with the thesis advisor.
- 865 Chemical Process Safety and Loss Prevention (3)** (Prereq: ECHE 720) Chemical process quantitative risk analysis, consequence modeling, risk estimation, and hazards assessment; design principles including inherent safety and mitigation techniques; elements of process safety management.
- 899 Dissertation Preparation (1-30)** To be arranged by candidates for the doctor of philosophy degree with advisor.

XI. Proposal Preparation Guidelines

General Guidelines

The reader should be able to determine easily the following points:

1. Exactly what problem do you propose to solve?
2. How do you propose to solve this problem?
3. What is new and unique about your proposed solution?
4. Why does the work need to be done?
5. Is this effort worthy of a Ph.D.?

Remember that you are trying to convince the reader to invest a sizable amount of money in your research program. You must convince the reader of two things:

1. The solution to the problem you have proposed is of sufficient benefit to chemical engineering practice to be worthy of the requested investment.
2. You are technically competent and capable of completing the proposed work in a satisfactory manner.

Proposal Format

Project Summary (One page): This page is to be written according to the guidelines of the National Science Foundation or, for biologically-oriented projects, the National Institutes of Health. For NSF proposals, this page must summarize the objectives, the work to be done, and must specifically describe both the Intellectual Merit and the Broader Impacts of the research project. More details on requirements are available at the NSF website. Students may search for awards, and view actual Project Summaries, at the NSF award search website:

<http://www.nsf.gov/awardsearch/>. For NIH proposals, the project summary should list the broad, long-term objectives and the specific aims of the research proposed, for example, to test a stated hypothesis, create a novel design, or develop new technology. This page should also contain a one-to-three-page statement of the Public Health Relevance of the research. More details on the requirements are available at the NIH grants website. For NIH proposals, students may search the “NIH Grants Reporter” at <https://reporter.nih.gov/> to view samples of actual project summaries.

Introduction: This section should start with the objectives and goals of the proposed research. Next, it also should contain a section on Engineering Relevance which explains the importance of the proposed work to chemical engineering practice. Finally, it should provide a review of the current state of the art in the area of the proposed work.

Theory: This section should discuss the theoretical basis for the proposed work. If experimental work is involved, the theory of the experiment should also be discussed.

Procedure: This section should discuss the procedure to be applied to the solution of the proposed problem. For theoretical problems, the procedure section should describe the proposed approach to solving the problem, including the various mathematical techniques that may be used. For experimental work, a detailed description of the apparatus is expected, including a subsection that discusses any pertinent safety considerations. Preliminary results should also be reported in this section.

Proposed Work Schedule: This section should contain an estimated time schedule for the proposed work.

References: This section contains complete bibliographic references (including title) to all literature cited in the previous sections.

Resume: This section contains a resume of the student. The resume should include educational background, work experience, publications, presentation, etc.