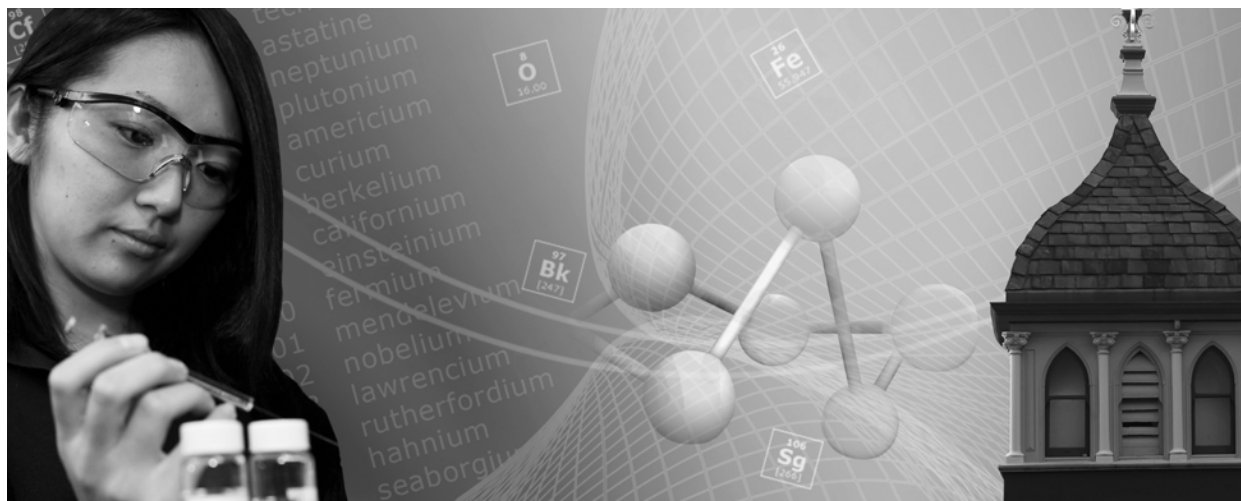


Chemical Engineering

DEPARTMENT OF CHEMICAL ENGINEERING • UNIVERSITY OF CALIFORNIA, BERKELEY



Graphic by Leigh Moyers

Graduate Student Handbook

**For Faculty, Students, and Staff
2008-2009**

TABLE OF CONTENTS**Page Information for New Graduate Students**

4	Academic Advisers
4	Appointments and Duties <ul style="list-style-type: none">○ GSR○ GSI
4-5	Fellowships <ul style="list-style-type: none">○ Fellowship Bonus for External, Competitive Fellowships
5	California Residency for Tuition Purposes <ul style="list-style-type: none">○ Entering Students○ Continuing Students
5	Vacation
5	Outside Employment
6	Selection of Research Topics
6	Desk and Study Space
6	Research Seminars
6-7	Graduate Student Advisory Committee (GSAC)
7-9	Requirements and Examinations for Ph.D. Candidates <ul style="list-style-type: none">○ Coursework Requirements○ Preliminary Examination○ The Qualifying Examination○ Annual Progress Report○ Presentation of Research
9-10	Requirements for M.S. Candidates <ul style="list-style-type: none">○ Coursework Requirements○ Annual Progress Report○ M.S. Thesis○ Product Development Program M.S. Degree
11	Graduate Student Appeals Procedure

Ph.D. Degree Requirements

12-13	Checklist for Completion of Doctoral Degree
14	Coursework Approval Request Form
15	Admission to the Ph.D. Program
15-16	Dissertation Research
16	The Preliminary Exam
17-20	The Qualifying Exam <ul style="list-style-type: none">○ Examination Deadlines○ Nature of the Examination○ Conduct of the Examination
20	Advancement to Candidacy
20	Graduate Student Instructor (GSI) Service

- 21-24** Coursework Requirements
- 24** The Annual Progress Report, Time in Candidacy, and Limitation of Residency
- 25** Satisfactory Progress
- 25** Filing Fee
- 26** Dissertation Requirements
- 27-30** Summary of Initial GPCC Discussions on the Format Content of the Written Part of the Qualifying Exam

M.S Degree Requirements

- 31** Checklist for Completion of Thesis Masters Degree
- 32** Background
- 32** Course Load per Semester
- 33** Unit and Grade Requirements
- 33** Advancement to Candidacy
- 33** Progress Reports
- 33-34** Thesis Requirements
- 34** M.S. Program in Chemical Engineering for Students with a B.S. in a Different Field
- 34-35** Residence Requirements
- 35** Filing Fee

Resources for Graduate Students

- 36-38** Resources for Graduate Students

INFORMATION FOR NEW GRADUATE STUDENTS

Academic Advisers

The Department of Chemical Engineering's head graduate adviser serves as the academic adviser to graduate students. The head graduate adviser also serves as the chair of the Graduate Education Committee (GEC). A student may consult with the head graduate adviser on any academic matter after arriving in Berkeley. The head graduate adviser is currently Professor David Graves. A student's research adviser is expected to play an important role in mentoring and advising during graduate study.

Appointments and Duties

A GPA of at least 3.1 is required to hold GSR or GSI appointments.

- **Graduate Student Research Assistant (GSR)**

Research assistantships are the usual means of support for graduate students for those terms in which they do not hold a formal GSI appointment. Duties of the GSR are to aid in the formulation, execution, and reporting of a research project. This project constitutes the thesis work done by the student to obtain a M.S. or a Ph.D. degree. The stipend for a GSR comes from contract or grant funds; hence, it is necessary that a student supported as a GSR pick a research topic that carries such funds.

- **Graduate Student Instructor (GSI)**

The duties of a graduate student instructor (GSI) are to aid in the instruction, conduct, and grading of a course. Normally this will involve attending the lectures for the course, setting aside 2 or 3 hours per week for consultation with students in the course, and assisting in the development and grading of homework problems and quizzes. In some cases, actual classroom instruction by the GSI may be expected. A GSI nominally is responsible for 16 to 20 hours per week for duties connected with the course. The department regards experience as a GSI to be highly valuable to a student whether or not a teaching career is chosen. Because of this, we require that all Ph.D. candidates serve as a GSI for a total of 2 semesters during their first 3 years (usually in semesters 3 and 6).

Fellowships

Students are strongly encouraged to apply for fellowships outside of the University. The National Science Foundation (NSF), the Fannie and John Hertz Foundation, the National Defense Science and Engineering Graduate Fellowship, the Department of Defense, and many other organizations are sources of such funds. A student receiving an outside award may also be eligible for a fellowship bonus from the department.

- **Fellowship Bonus for External, Competitive Fellowships**

The faculty has discussed and has agreed, in principle, that the standard stipend for graduate students with external, competitive fellowships may be supplemented such that the student will receive a 15% bonus over the standard stipend. In the case of small fellowships (fellowships less than the standard stipend*15%), the bonus over the standard stipend will be no greater than the amount of the fellowship. In the case of large fellowships (fellowships greater than the standard stipend*1.15) and to honor previous commitments of the department, the total to the student will be at least \$31,100 per year. This bonus does not apply to fellowships which are controlled by the department and are used in the normal course of providing the standard stipend to certain students and requires no particular effort on the part of the student.

California Residency for Tuition Purposes

- **Entering students**

Entering students who are U.S. citizens or permanent residents are provided non-resident tuition for the first year. Support is awarded on the basis of scholastic ability and availability of funds. The department does not provide non-resident tuition support beyond the first year to U.S. citizens or permanent residents.

- **Continuing students**

Continuing students who are U.S. citizens or permanent residents are expected to become legal residents of California during their first year in residence and hence would not be subject to non-resident tuition in subsequent years. Non-resident tuition for international students is typically paid by the department.

Vacation

Graduate students who hold University appointments are entitled to administrative holidays given by the University, plus an annual vacation of two weeks. Students must consult their research advisers to work out a mutually agreeable time period for vacation leave. Vacations or leaves of absence should not interfere with duties as graduate student instructors. Graduate Student Instructors are expected to be in residence the entire semester. No accrual of vacation or payment as salary is permitted.

Outside Employment

Graduate students in the Department of Chemical Engineering are normally considered full-time students. The stipend and fees give support provided the student is making satisfactory progress to the degree. Any student considering employment outside the department must discuss the

advisability of such employment with and receive written approval from that student's research adviser and the head graduate adviser.

Students holding fellowships are also considered full-time students and may not accept employment beyond the fellowship. Should the student and the research adviser agree that outside employment will assist the student's research, the head graduate adviser and the dean of the Graduate Division must concur, and the Fellowship Office must be notified and the outside employment justified to the granting agency.

Selection of Research Topic

A list of research projects will be made available at the beginning of the fall semester. The faculty will hold informational sessions about their research during the month of September. Students are required to consult with faculty members about research projects and have discussions with students working with those faculty members. Students are encouraged to speak with all faculty members and to cover many different research areas. Students are asked to submit a list to the head graduate adviser of their top three preferences for faculty research adviser, together with their choice of research projects for each adviser. The head graduate adviser will then assign each new student to a faculty research adviser, basing the decisions upon student and faculty preferences and availability of projects. Every effort is made to satisfy the maximum possible number of people to the greatest possible extent in this process.

Desk and Study Space

A desk and study space are provided to each graduate student. This desk usually will be in or near the room where the student is doing research. Graduate students will be issued keys to all College of Chemistry buildings, the ChE graduate student lounge, and their respective research laboratories.

Research Seminars

The department colloquium is held on Wednesday afternoons from 4:00 to 5:00 pm. All graduate students are expected to attend this colloquium, for which they receive graded academic credit. Speakers include Berkeley faculty members, visiting scholars, Ph.D. candidates, and engineers and scientists from industry and academia. Special departmental seminars also are held from time to time, and announcements will be posted.

Individual faculty members within the department hold research seminars during most terms; these most often consist of graduate students working with that faculty member presenting seminars on their own research.

Graduate Student Advisory Committee (GSAC)

Within the department, the Graduate Student Advisory Committee (GSAC) speaks for the students. Representatives of GSAC meet with the department's Graduate Policy Committee each term to discuss relevant departmental problems. This is one way students may make suggestions to the faculty. A departmental picnic and several intramural sports teams are also organized by GSAC.

The leadership of GSAC generally is selected in September, with several members continuing from the preceding year. At least one seat is reserved for new students. Anyone interested in becoming or nominating a representative should contact one of the current leaders early in the fall semester. The current GSAC leadership includes Bean Getsoian, Penny Gunterman, Sarah Huffer, Joanna MacKay, Dana Nadler, and Will Vining. GSAC leadership can be contacted at gsac@lists.berkeley.edu.

Requirements and Examinations for Ph.D. Candidates

For more detailed information please refer to the section, “Ph.D. Degree Requirements,” in this handbook.

- **Coursework Requirements**

A total of 30 units of letter-graded courses must be taken during residence in the doctoral program. This requirement includes a 12-unit core program in chemical engineering, an additional 6 units selected from departmental graduate level electives, a 9-unit technical sequence in an outside specialty, and 3 units in either the departmental or technical sequence category.

In addition to these 30 units, the department recognizes that practicing chemical engineers draw increasingly on information from other disciplines. Students are strongly encouraged to pursue additional courses of specific relevance to their thesis research and to explore other areas of technical, professional, or personal interest. The selection of courses to satisfy the breadth requirement and the minor emphasis is done with the advice and approval of the head graduate adviser.

Students are expected to take four courses the first semester and two or three courses the second semester in the first academic year.

- **Preliminary Examination**

The preliminary examination is held prior to the beginning of the second semester to assess student learning and critical thinking skills. The exam also ensures adequate knowledge of fundamental graduate and undergraduate course material. Ph.D. students normally will take this examination the first time it is given after they enroll. (Students who wish to postpone the exam must obtain the approval of both their research adviser and the head graduate adviser.) The examination is oral and consists of three parts: a) transport phenomena; b) thermodynamics, kinetics, and chemical fundamentals; and c) process engineering and design.

Each part lasts about 40 minutes. Basic principles of chemical engineering and chemistry are covered. The examination uses material normally included in an accredited undergraduate chemical engineering curriculum in the United States. Typical questions involve heat transfer by conduction and convection, condensation, boiling, energy and momentum balances in fluid mechanics, diffusion, simultaneous heat and mass transfer, chemical equilibrium, thermodynamic cycles, thermochemistry, reaction rates, reactor design, separation processes, process control, process analysis, and process synthesis. Students who have taken a graduate

level course in any of these areas may be questioned on this material as well. The student's understanding and ability to apply this knowledge to chemical engineering problems will be probed.

Useful review material will be found in texts such as the following:

Transport Processes:

Perry, *Chemical Engineers' Handbook*, Sections 5, 10, 14
Bird et al., *Transport Phenomena* (elementary chapters)
Denn, *Process Fluid Mechanics*
Welty et al., *Fundamentals of Momentum, Heat & Mass Transfer*

Thermodynamics, Kinetics, and Chemical Fundamentals:

Smith, Van Ness, and Abbott, *Chemical Engineering Thermodynamics*
Levenspiel, *Chemical Reaction Engineering*
Atkins, *Physical Chemistry*

Process Engineering and Design:

Peters and Timmerhaus, *Plant Design and Economics for Chemical Engineers*
Chapters 1, 2, 3, 9, and 10
King, *Separation Processes*

To pass the preliminary exam, students must display acceptable performance on at least two of the three sections of the exam. The results of this examination and performance in coursework, along with a statement from the student's research adviser, are used by a committee of the faculty to evaluate the student's progress toward the Ph.D. degree. Students who do not meet minimal performance criteria may be placed in the thesis research M.S. degree program prior to taking the exam again. A failing performance in the examination, together with unsatisfactory performance in coursework, may also result in dismissal from the graduate program. To be reconsidered for the Ph.D. program, the student must apply for readmission to the Ph.D. program near the end of the M.S. research project. The Graduate Education Committee (GEC) will decide if admission to the Ph.D. program is recommended and whether the entire preliminary examination must be retaken. One retake of the preliminary exam is permitted.

- **The Qualifying Examination**

The qualifying examination is an examination required as part of the Graduate Division's formal procedure for advancement of a student to candidacy in the Ph.D. program. In Chemical Engineering, this examination consists of a formal oral examination and of a scholarly written description of the dissertation research. The oral exam is a presentation to a 4-member qualifying exam committee and lasts approximately two hours. The written part is a technical description of the dissertation research. The exam will take place in the beginning of the fifth semester of study. The oral examination cannot be scheduled if the written manuscript is not submitted. Students who do not submit a written manuscript will be placed in the M.S. program.

This examination may be taken only after successful completion of the preliminary examination. For more details, see the document, *Ph.D. Degree Requirements*.

- **Annual Progress Report**

The Graduate Education Committee (GEC) and the Graduate Division review the progress of the student each year in June. The student submits a short report describing the degree of completion of research, the tasks yet to be finished, and a projected schedule for completion to degree. The report is submitted to the GEC and must be signed by the research adviser, one other member of the dissertation committee, and the head graduate adviser.

- **Presentation of Research**

As part of the requirement for the Ph.D. degree, each student is required to present a final seminar based on his or her dissertation. The seminar will be one of the Wednesday afternoon colloquia or may be separately scheduled. A brief summary of the dissertation, no more than four typed pages including figures and diagrams, should be submitted for duplication and subsequent distribution to the faculty at least one week prior to the seminar.

- **Residence and Dissertation Requirements**

To obtain the Ph.D. degree, a student must maintain residency until a satisfactory dissertation describing his or her research has been filed. The dissertation will be evaluated and must be signed by a three-to-four-member committee appointed by the Graduate Division. The chair of this committee is the student's research adviser. A GPA of 3.0 or higher is required to remain in good academic standing and for graduation.

Requirements for M.S. Candidates

For more detailed information please refer to the section, "M.S. Degree Requirements," in this handbook.

Research M.S. Degree

- **Coursework Requirements**

Twenty units, of which at least 14 units must be letter graded, are required for the degree. Of the 14 graded units, 9 or more must be selected from graduate-level (200 series) chemical engineering courses and the remainder from a variety of upper-division science, engineering, and business courses. Students are expected to take three courses the first semester and two courses the second semester to complete the minimum course requirements in the first academic year.

- **Annual Progress Report**

The GEC and the Graduate Division review the progress of the student each year in June. The student submits a short report describing the degree of completion of research, the tasks yet to be

finished, and a projected schedule for completion to degree. The report is submitted to the GEC and must be signed by the research adviser, one other member of the thesis committee, and the head graduate adviser.

- **M.S. Thesis**

The M.S. research thesis forms a central part of the program. The student must maintain residency until a satisfactory thesis describing his or her research has been filed. The M.S. thesis is read by a committee of three professors and must be signed by them. The chairman of this committee is the student's research adviser, one other member is from the Department of Chemical Engineering, and the third is from another department. In order to file the M.S. thesis with the Graduate Division, the student must be advanced to candidacy for the Masters degree and have a 3.0 GPA.

Product Development Program M.S. Degree

Started in 2006, this is a new program leading to a M.S. degree (Plan II) in one calendar year. The general requirements of 24 units and a comprehensive final examination include two specific courses (ChE 295P and 295Q) in product development and an internship in a local industry leading to a field study report. See a more detailed description at <http://cheme.berkeley.edu/PDP/index.html>

Graduate Student Appeals Procedure

Depending upon the nature and magnitude of the grievance, our graduate students have recourse to the following step-by-step procedure:

1. Bring the grievance to the attention of the academic adviser for the student's degree. The grievance can be informally presented as an oral complaint, which should be presented and answered within 30 days of the action that is the subject of the complaint or of the student's knowledge of such action. Alternatively, a formal complaint may be submitted in writing to the head graduate adviser.
2. Seek resolution from the head graduate adviser. A written complaint must be received by the head graduate adviser within 30 days of the occurrence of the action provoking the complaint. The department should complete its investigation and notify the student of the outcome of the investigation within 60 days of receipt of the complaint. Alternatively, a formal complaint may be submitted in writing to the Grievance Committee.
3. Appeal to the department's GEC, particularly in matters relating to candidacy, withdrawal from the University, or petition to change degree goal. The appeal should be presented and answered within 30 days of the head graduate adviser's decision in step 2.
4. Request a joint decision from the chair and vice chair, who have final authority. The request should be presented and answered within 30 days of the decision rendered in step 3.
5. If the student is not satisfied with the outcome of the complaint under the department's procedure, the student may bring the complaint to the Graduate Appeals Procedure. The formal appeal must be received in the Office of the Dean of the Graduate Division within 15 days of the written notification of the result of the departmental decision.
6. The full graduate appeals procedure (approved April 27, 1998) is available at the Graduate Division website, <http://www.grad.berkeley.edu/current>.

In attributions of authorship of research carried out jointly by faculty and graduate students, the names of all major contributors will appear on the paper.

The Department of Chemical Engineering supports the University policy on sexual harassment. Please refer to the Berkeley Campus Title IX website, <http://equity.chance.berkeley.edu/titleix.shtml>. Students are reminded that virtually any sexually-oriented language, conduct, or behavior can be viewed as sexual harassment if it is unwelcome. Remember, it is the impact of the conduct or behavior on the recipient (or on observers) not the intent of the harasser that determines findings of sexual harassment.

CHECKLIST FOR COMPLETION OF THE DOCTORAL DEGREE**1. Registration Requirements*****Every semester:***

- Department colloquium (1 unit)
- Seminar with adviser (1 unit)
- Research with adviser (variable up to 12 units)

For semester in which it occurs:

- GSI credit (2 units)
- Qualifying exam credit (2 units)

2. Coursework Requirements (letter graded)***Complete Core Courses (12 units)***

- ___ ChE 230 Mathematical Methods
- ___ ChE 240 Thermodynamics
- ___ ChE 244 Kinetics & Reaction Engineering
- ___ ChE 250 Transport Processes

Complete Department Electives (6 units)

Complete Minor Requirement (9 units)

Complete either Department or Minor Course (3 units)

3. Preliminary Exam (mid-January of first year)**4. Graduate Student Instructor Service (2 rotations)**

- ___ 3rd semester
- ___ 6th semester

5. Annual Progress Reports (June)

Meet with research adviser and dissertation committee members, and submit annual progress report

6. Minor Requirement

___ Minor approved by head graduate adviser

7. Qualifying Exam (beginning of 5th semester)

___ Submit topic for assignment of committee chair (*early spring*)

___ Consult with chair and recommend committee members (*spring*)

___ Submit three subject areas for qualifying exam application (*summer*)

___ Submit 25-page technical manuscript (*mid-August*)

___ Apply to advance to candidacy immediately after passing exam

8. Presentation of Research at Department Colloquium

___ Schedule talk with faculty colloquium coordinator

___ Submit abstract *signed by research adviser* for distribution

9. Apply for Filing Fee Status if Appropriate**10. File Dissertation with Graduate Degrees, 318 Sproul Hall**

See website for guidelines: <http://www.grad.berkeley.edu/current/index.shtml>

11. Check-out with department graduate office

___ Check-out form

___ College of Chemistry alumni questionnaire

___ GSAC survey

___ Copies of thesis for research adviser(s)

COURSEWORK APPROVAL REQUEST FORM

Please check one: **New** _____ **Revised** _____

Name: _____ Date: _____

I have completed the following core graduate chemical engineering courses. *(12 letter graded units)*

Course# and Name: _____ Units 3 Grade _____

Course# and Name: _____ Units 3 Grade _____

Course# and Name: _____ Units 3 Grade _____

Course# and Name: _____ Units 3 Grade _____

I propose the following courses to fulfill my **chemical engineering elective requirement** for the doctoral degree. *(6 letter-graded units from 200-level departmental courses and ChE 170, 178, and 179. At least one graduate course is expected. (Chemical Engineering electives are chemical engineering courses.)*

Course# and Name: _____ Units _____ Grade _____

Course# and Name: _____ Units _____ Grade _____

Course# and Name: _____ Units _____ Grade _____

I propose the following courses to fulfill my **minor requirement** for the doctoral degree. *(9-unit letter-graded technical sequence from upper division and graduate courses in other departments.)*

Minor title: _____

Course# and Name: _____ Units _____ Grade _____

Course# and Name: _____ Units _____ Grade _____

Course# and Name: _____ Units _____ Grade _____

The following course(s) fulfills the remainder of the coursework requirement for the doctoral degree. *(3 letter-graded units from either 200-level departmental courses and ChE 170, 178, and 179; or upper division and graduate courses in other departments.)*

Course# and Name: _____ Units _____ Grade _____

Course# and Name: _____ Units _____ Grade _____

Approved: _____ Date: _____

Head Graduate Adviser

REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Admission to the Ph.D. Program

Qualified students who so request are admitted directly into the Ph.D. program at the time they are admitted to graduate study in chemical engineering. Students who entered the thesis research M.S. program may request the head graduate adviser to switch them into the Ph.D. program during their first semester of residence but before the selection of a research project. Students lacking the necessary undergraduate chemical engineering curriculum may be required to complete the thesis research M.S. degree before being considered for admission to the Ph.D. program.

Students who have been in the thesis research M.S. program for more than one semester and who wish to transfer to the Ph.D. program should submit a written request to the chair of the GEC stating purpose and plans. This request should be submitted as soon as a decision has been made, but in all cases before the end of the fall semester of the second year. Each request will be judged by the GEC on the basis of M.S. research performance and academic record. Upon approval, the student will be permitted to take the preliminary examination the next time it is given. After passing the preliminary exam and completing the M.S. thesis, one to two semesters will be specified by the GEC in order to complete the qualifying examination.

Dissertation Research

A research adviser is assigned to each student during the first semester by the head graduate adviser. Such assignments are made after the student has interviewed all faculty members with projects of interest to the student and after the student has submitted a list of the top three faculty members, ranked on the basis of the student's preference, to the head graduate adviser. The head graduate adviser will endeavor to satisfy one of these top three preferences for every student within the restrictions imposed by the limited number of available positions and by the need to balance the distribution of students among research groups with available positions. Assignment to a specific research project is then made after discussions with students and the faculty.

A short written progress report on the dissertation research must be prepared by each student at the end of the spring semester during each year of residence. The report must be signed by the research adviser, and after advancement to candidacy, by one other member of the dissertation committee. After review and approval by the GEC, the report will be forwarded to the Graduate Division.

A student must maintain residency until course requirements are completed and a satisfactory dissertation, containing the full details and the results of the research, has been submitted. The research project lasts until the student has made significant progress in research and demonstrated a high level of creativity and mastery of the scientific, engineering, and mathematical concepts relevant to the topic. These matters are judged by the research adviser and by the faculty members composing the dissertation committee. The Ph.D. degree is granted after these individuals have read and approved the dissertation.

A student wishing to change research adviser(s) before completing the assigned project must first consult the head graduate adviser. After this consultation, the head graduate adviser will present the case to the GEC, which will rule promptly on the appropriateness of the change and on the procedures for implementation.

A research adviser wishing to discontinue association with a student because of unsatisfactory performance must discuss the situation with the GEC before proceeding with dismissal procedures.

The Preliminary Examination

The preliminary examination is held before the start of the second semester. It is conducted in order to assess student learning and critical thinking skills, as well as to ensure adequate knowledge of fundamental graduate and undergraduate course material. Ph.D. students will normally take this examination the first time it is given after they enroll. (Students who wish to postpone the exam must obtain approval of both their research adviser and the head graduate adviser.) The examination is oral and consists of three parts: a) transport phenomena; b) thermodynamics, kinetics, and chemical fundamentals; and c) process engineering and design.

Each part of the preliminary examination lasts about 40 minutes. The examination covers basic principles and concepts in chemical engineering and chemistry normally included in accredited undergraduate chemical engineering curricula in the United States. Typical questions include problems related to heat transfer by conduction and convection, condensation, boiling, energy and momentum balances in fluid mechanics, diffusion, simultaneous heat and mass transfer, chemical equilibrium, thermodynamic cycles, thermo-chemistry, reaction rates, reactor design, separation processes, process control, process analysis, and process synthesis. Students who have taken a graduate-level course in any of these areas may also be tested on such graduate-level material. The examination attempts to probe and assess the student's understanding of chemical engineering concepts and ability to apply this knowledge to the solution of chemical engineering problems.

The student's performance in this examination and in first-year coursework, along with a statement from the student's research adviser, are used by a committee of the faculty in order to evaluate the student's progress toward the Ph.D. degree. Students who do not meet minimal performance criteria may be asked to complete the thesis research M.S. degree before attempting to take the preliminary exam again. In such cases, readmission into the Ph.D. program will require that the student reapply for admission to the Ph.D. program near the end of the M.S. research project. The Graduate Education Committee (GEC) will then make recommendations on admission to the Ph.D. program and on whether the entire preliminary examination must be retaken. One retake of the preliminary exam is permitted. The M.S. thesis must be completed before readmission into the Ph.D. program. Failing the preliminary exam, together with a poor performance in required coursework, may be grounds for dismissal from the graduate program.

The Qualifying Examination

The qualifying examination is required as part of the Graduate Division's formal procedure for advancement of a student to candidacy in the Ph.D. program. In Chemical Engineering, this examination consists of a formal oral examination and of a scholarly written description of the dissertation research. The oral part of the exam consists of a presentation on the dissertation research to the qualifying examination committee lasting about two hours and including questions in areas of chemical engineering, chemistry, and related disciplines. The written part consists of a technical manuscript (maximum of 25 pages) provided to the department graduate office for distribution to the qualifying examination committee no later than one week before the first day of the fifth semester in residence. The oral examination cannot be scheduled if the written manuscript is not submitted. Students who do not submit a written manuscript will be placed in the thesis research M.S. program. Under unusual circumstances, students may petition the GEC for an extension of the deadline for submission of the written document.

Both parts include formal descriptions of the research program, including background and objectives, a rigorous and current review of the relevant literature, description of methods, a discussion of research results and accomplishments to date, and detailed plans and milestones required for completion of the Ph.D. degree. In both parts of the exam, the student is expected to demonstrate mastery of chemical engineering fundamentals, proficiency in the research area, general scientific and professional competence and promise, and significant accomplishments in the dissertation research.

- **Examination Deadlines**

For students entering the Ph.D. program directly, the qualifying examination must be taken before the end of the fifth semester of residence. For students admitted to the Ph.D. program from the thesis research M.S. program, the deadline will be set on an individual basis by the GEC.

The approximate week of each student's examination will be set by the head graduate adviser in consultation with the chair of the student's qualifying examination committee. The graduate office will schedule the examination date as faculty schedules permit but will endeavor to arrange exams for every student to take place before the fifth week of the fifth semester of residence. Individual students can coordinate the scheduling of their own examinations, but the same deadlines apply.

- **Nature of the Examination**

Purpose and Philosophy of the Examination

The purpose of the qualifying examination is to test the student's ability (1) to define, describe, and examine critically, the Ph.D. research project; (2) to think creatively and to apply basic chemical engineering concepts; (3) to communicate in a scholarly and rigorous manner the

progress and results of research; and (4) to conduct productive, rigorous, and creative scientific research.

One week before the official start of the fifth semester of residence, the student will submit a technical manuscript with a maximum length of 25 pages, written in accordance with accepted guidelines for technical journals in the area of the research. (See the summary of format and content of the written part of the qualifying exam at the end of this section.) This manuscript should describe concisely and clearly the relevance of the problem, the details and novelty of the approach, the extent and significance of the research results, and the plans and milestones for the completion of the degree within normative time.

For the oral part of the exam, the student should prepare a seminar based on the methods and accomplishments of the research project and lasting approximately 45 minutes. The student will be examined on general knowledge of the research area, understanding of the relevant theoretical and experimental methods, in-depth knowledge of the relevance and uniqueness of the project, and ability to interpret results and to design a sound research strategy. The student must also show the ability to identify and apply any principles of chemistry, physics, and chemical engineering required for the critical analysis of the research results and of the proposed plan of attack.

All qualifying examination committee members may not be experts in all areas covered by the research project. Therefore, the student should prepare the manuscript and the oral presentation with all details required in order to communicate with technically trained non-experts and with minimal use of jargon and ill-defined concepts or terms.

- **Conduct of the Examination**

Selection of the Committee

In the fourth academic semester of residence, the head graduate adviser will request a member of the departmental faculty to act as the chair of the qualifying exam committee for each student. During this semester, the committee chair will be available to the student in order to clarify guidelines, requirements, and expectations for the qualifying exam. The student should enroll for two units of ChE 602, supervised by the committee chair, in the semester when the exam is taken.

The qualifying exam committee chair and three additional committee members will be appointed by the dean of the Graduate Division, based on the recommendation of the head graduate adviser, by the end of the fourth semester of residence. The exam date must also be set at least two weeks before the start of the fifth semester of residence. The student's research adviser may not serve on this committee. At least one of the committee members must be a member of the Berkeley Academic Senate from outside the Department of Chemical Engineering. Every attempt will be made to choose outside members with significant knowledge in the area of the research project.

The head graduate adviser will recommend the composition of qualifying exam committees on the basis of all available information and input. Specific suggestions from the student should be communicated via the chair of the qualifying exam committee during normal conferences conducted throughout the fourth semester.

Examination Procedure

In the oral part of the exam, the student will make a formal presentation of the research program, including review of the most relevant literature, accomplishments to date, and plans for future research. The entire presentation should be designed to occupy about 45 minutes. Usually, the committee will interject questions so that the entire exam will take about two hours. This oral exam, along with the written manuscript, constitutes the qualifying examination for the Ph.D. candidacy; therefore, the student should be able to answer general questions in the general field of chemical engineering in addition to those specifically based on the research presentation and manuscript.

The qualifying exam committee members will complete evaluation forms covering both the oral and written part of the examination. The committee chair will also prepare a short summary of the conclusions of the committee. The evaluations and the summary will become part of the permanent record of the student.

Policy for Reporting Results of Qualifying Exams

The goal of the examining committee is to reach a unanimous conclusion, in an expeditious manner, regarding the candidate's potential for success in the doctoral program. At the end of the examination, the committee will provide a written summary of the outcome and conclusions. Possible votes of the committee are pass, fail, or fail with recommendation to retake exam. The final vote of the committee will be forwarded to the Graduate Division, and the written summary of the exam will be included in the permanent departmental records of the student.

At the conclusion of the examination, the student will be asked to leave the room. After a thorough discussion by committee members, the student will be informed of the outcome and decision of the committee (pass or fail) and whether the committee recommends re-examination in case of unsatisfactory performance in the examination.

Under exceedingly extreme circumstances, such as illness or extreme psychological stress, an exam in progress may be recessed. The circumstances prompting the recess should be so extraordinary that a recessed exam is an extremely rare event. The period of such a recess would normally be a few days, but it should never exceed three weeks. The dean of the Graduate Division must be notified when a qualifying examination is recessed.

A student who is to take a reconvened exam will be told of this fact by the committee chair and receive the same information in a letter, stating precisely the special conditions for a second or continued exam, and the time schedule. A copy of this letter is to be sent to the student's file, to the research adviser, and to the dean of the Graduate Division. At the conclusion of the reconvened examination, the committee should decide whether the candidate passed, failed with recommendation that a second exam be given, or failed.

A student who fails to take a recessed exam or a “failed with recommendation to retake” exam will automatically receive a fail grade for the examination. The examination committee chair must immediately submit a written report of a failure to the Graduate Division. The failure must also be recorded on the student's permanent departmental records. The department graduate office will inform the Graduate Division of the change in degree goal of such a student, who is required to switch into the thesis research M.S. program. After modifications requested by the committee members and by the research adviser are implemented, the technical manuscript will be submitted for approval as a M.S. thesis by the end of the fifth semester of residence. If approved, this manuscript will satisfy the thesis requirement for a M.S. degree and a M.S. degree will be granted.

Advancement to Candidacy

After the qualifying examination has been passed, Graduate Division will be notified, and the student should file an application to advance to candidacy for the Ph.D. Degree. The completed application and payment of \$90 is made to Graduate Degrees in 318 Sproul Hall. The advancement application should be filed before the first day of the semester following the successful qualifying exam. The student must have a minimum grade point average of 3.0 in order to qualify for advancement. (Those students who are required to file a M.S. thesis prior to readmission into the Ph.D. program will not be approved for advancement to candidacy until the M.S. thesis is filed.)

A dissertation committee is chosen as part of the advancement application. The student and the research adviser propose three members of the Berkeley Academic Senate as readers of the dissertation. The research adviser is the chair of this dissertation committee. One member of this committee must be a member of the Berkeley Academic Senate from outside the Department of Chemical Engineering. If the thesis adviser is outside the Department of Chemical Engineering, a dissertation committee of four (or more) is generally required. At least half of the committee co-chairs must be a member of the department, at least half of the committee members must be in the department, and at least one member who is not a co-chair must be a member of the Berkeley Academic Senate from outside Chemical Engineering. One committee member from outside the Berkeley Academic Senate may be selected, provided that the qualifications of the proposed member satisfy the requirements of the Graduate Division.

Graduate Student Instructor [GSI] Service

We regard the GSI activities as a valuable educational component of the Ph.D. program, whether or not the student chooses a teaching career. Therefore, we require all students in the Ph.D. program to serve as a GSI for two semesters during the first three years, typically the third and the sixth semester of residence. GSI duties include assisting in the instruction, conduct, and grading of a chemical engineering course. This normally involves attending the lectures, being available for student consultations for 2 to 3 hours per week, and assisting in formulating and grading exams and grading or supervising the grading (by readers) of homework problems. Classroom instruction may also be part of the GSI duties. GSI activities typically occupy about 20 hours per week. **A GPA of 3.1 is required for GSI or GSR appointment.**

Coursework Requirements

Ph.D. candidates in Chemical Engineering are required to complete a research dissertation of significant depth and creativity. Students are also asked to complete a program of coursework in order to provide a broad base of technical knowledge in chemical engineering and in related areas outside this field. The latter are stressed in the coursework because practicing chemical engineers frequently draw upon knowledge and concepts from other scientific disciplines.

A total of 30 units of letter-graded courses must be taken during residence in the graduate program. Twelve units derive from a required core of four chemical engineering courses in the areas of mathematics, thermodynamics, reaction engineering, and transport phenomena; 6 units from departmental graduate level courses and from Chemical Engineering 170, 171, 176, 178, and 179 (at least one graduate course is expected); a 9-unit technical sequence from upper division and graduate courses in other departments; and 3 units in either the departmental or technical sequence category.

Graduate courses taken while in graduate standing at other universities and completed with a grade of B or higher, may also be applied to satisfy specific core course requirements with the approval of the head graduate adviser. The student will not be required to duplicate material already covered; however, the student still needs to satisfy the required minimum of 30 letter-graded units. In other words, students will not be required to repeat a course taken elsewhere but units for such courses may not count toward the unit requirement for the degree. The head graduate adviser must approve any exception from specific course and unit requirements. Students are strongly encouraged to pursue additional courses of specific relevance to the thesis research and to explore other areas of technical, professional, and personal interest.

All students must register for and attend the weekly departmental colloquium during each semester of residence.

To summarize the coursework requirements:

1. 12 units from core chemical engineering graduate courses: ChE 230, ChE 240, ChE 244, and ChE 250.
2. 6 units from 200-level departmental courses and from ChE 170, ChE 171, ChE 176, ChE 178, and ChE 179. At least one graduate course is expected.
3. A 9-unit technical sequence with a particular emphasis from upper division and graduate courses in other departments.
4. 3 additional units, from 2 or 3 above.

Students are expected to take four courses during the first semester, two or three courses during the second semester, and one or two courses the third and fourth semesters. This should allow completion of most required coursework, one rotation of GSI service, and preliminary and qualifying exams by the end of the fifth semester, thus allowing the student to concentrate on doctoral research from this point on.

Students also enroll in ChE 299 (chemical engineering research with their adviser) throughout the course of their dissertation research and receive a letter grade during each semester. A student receiving poor grades in ChE 299 may be switched to the thesis research M.S. program.

The outside specialty (minor) is designed by the student and consists of a coherent sequence of courses in a technical field outside of chemical engineering. This excursion into another discipline will benefit the student by providing new concepts and perspectives, knowledge about novel techniques and methods of analysis, and identification of important new problems that can be solved by chemical engineering methods. The student is given considerable freedom in designing this sequence, provided that courses are (1) technical, (2) rigorous, (3) related in some meaningful way to each other, and (4) outside chemical engineering. Graduate courses are strongly preferred, but exceptions will be made in those areas where a chemical engineering background provides limited preparation. The sequence is to be approved by the head graduate adviser.

The following are examples of some acceptable outside sequences:

Integrated Circuit Processing

EECS 130	Integrated-Circuit Devices
EECS 143	Microfabrication Technology
EECS 243	Advanced IC Processing & Layout

Mathematical Analysis

Math 185	Introduction to Analysis
Math 204A	Ordinary & Partial Differential Equations
ME 281	Methods of Tensor Calculus & Differential Geometry

Material Science

MSE 204	Theory of Electron Microscopy and X-Ray Diffraction
MSE 223	Semiconductor Materials
MSE 225	Thin-Film Science and Technology

Inorganic Chemistry

Chem 104AB	Advanced Inorganic Chemistry
Chem 201	Fundamentals of Inorganic Chemistry
Chem 250A	Introduction to Bonding Theory
Chem 250B	Inorganic Spectroscopy
Chem 251AB	Coordination Chemistry I and II

Fluid Mechanics

ME 260A	Advanced Fluid Mechanics I
ME 260B	Advanced Fluid Mechanics II

plus one of the following:

ME 167	Microscale Fluid Mechanics
ME C213	Fluid Mechanics of Biological Systems
ME C243	Advanced Methods in Free-Surface Flows
ME 263	Turbulence

Biochemistry

MCB 102	Survey of the Principles of Biochemistry and Molecular Biology
MCB 206	Physical Biochemistry
Chem 271ABC	Chemical Biology

Management of Technology

(These courses may also be used as partial fulfillment of the Management of Technology Program Certificate)

Management of Technology Core Courses approved for minor requirement:

High-Tech Product Design and Rapid Manufacturing
Managing the New Product Development Process
Marketing for High-Tech Entrepreneurs
Introduction to Management of Technology
Managing Innovation and Change
International Trade and Competition in High Technology
Strategic Computing and Communications Technology
Biotech: Industry Perspectives and Business Development
Opportunity Recognition: Technology and Entrepreneurship in Silicon Valley

(Students seeking the Management of Technology Program Certificate, should take two of the above core courses plus 6 units of related courses. See the MOT website, http://mot.berkeley.edu/Berkeley_Students/Main_Student.htm The MOT Related Courses must be preapproved by the head graduate adviser.)

Product Development

Students may wish to construct a minor in Product Development. This entails satisfactory completion of courses ChE 295P and 295Q and 6 additional units. With approval, one of these

additional courses can be replaced by an internship in a local industry and a field study report. This generates a certificate in product development.

Designated Emphasis

The student's attention is also directed to the designated emphases, such as those in Nanoscale Science and Engineering (NSE) and Energy Sciences and Technology (DEEST).

The Annual Progress Report, Time in Candidacy, and Limitation of Residency

The department reviews the student's research status each June in order to ensure that students fulfill the degree requirements in reasonable conformity with the 10-semester normative time. Each year, the student must submit to the Graduate Education Committee (GEC) a short report, describing the progress of the research, the tasks remaining to be completed before a degree is granted, any expected difficulties or delays that would delay completion beyond normative time, and a projected schedule for completion of the dissertation. The student and the research adviser must reach a clear understanding of what is expected from each other and should engage in frank discussions in the course of assembling this short report. The grade given to the student for ChE 299 should reflect a realistic assessment of the student's performance based on the contents of this short report.

The report must be approved and signed by the research adviser, by one other member of the dissertation committee, and by the head graduate adviser. These reports will be used by the head graduate adviser to decide on the expected duration of funding required and by the Graduate Division to ensure timely progress to the degree. Students must be rigorous and accurate in setting up schedules and in meeting deadlines and milestones in the proposed research plans.

A student who fails to complete degree requirements at an adequate rate will have his or her advancement status shifted to "lapsed candidacy." Such status is automatically imposed by the Graduate Division four semesters after normative time. A student in this status cannot be appointed to GSI or GSR positions and such a student is considered to be on probation. Candidacy can be reinstated or extended by the Graduate Division due to extenuating circumstances upon recommendation by the head graduate adviser.

Satisfactory Progress

Our objectives are to have Ph.D. students complete their degrees in 10 semesters. Students and their research advisers will need to justify any extensions. With this in mind, the following stipend-reduction schedules will apply to degree candidates:

degree program	beginning in semester	stipend reduction %
Ph.D.	12	10
Ph.D.	13	50
Ph.D.	14	100

Exceptions to the stipend reduction schedule will be considered by the GEC, who will consult with both the student and the thesis adviser. In some cases, the GEC may decide that the student is also responsible for the fees and tuition.

Ph.D. students at the end of their 10th semester must submit a statement to the GEC if they anticipate their degree will not be completed by the 11th semester. The statement should summarize progress to date (briefly, not like an annual progress report), state what needs to be done, outline the schedule for completion, and justify any extension beyond the stipend schedule indicated above. For example, switching research directors or writing a M.S. thesis on an unrelated project first might be grounds for an extension.

Any petition should state what circumstances have arisen that make timely completion of the degree impossible and include a precise schedule of the postponed stipend reduction being requested. There should be a separate letter from the research adviser giving his or her own perspective of how the problem arose and how a specific postponement is justified.

For students who change advisers between the thesis research M.S. and Ph.D. programs, normative time for the Ph.D. *may* be extended by decision of the GEC.

Filing Fee

The filing fee should be used only in accordance with University policy.

The student must be either registered or in filing fee status in order to file the dissertation. The filing fee is paid in lieu of registration, and the student is considered to have withdrawn from the University. Under most circumstances, the research adviser can pay the filing fee and health insurance for the student. Filing fee status may be used only once, and the student must be readmitted to the University and re-registered and pay all fees if the dissertation is not filed by the expiration of the filing fee period.

No Ph.D. student will receive a stipend in any semester subsequent to the semester in which the filing fee is used in the event that the thesis still has not been filed. After leaving the University,

students are responsible for paying their own fees, whether these are the filing fee or regular fees on reinstatement.

Please consult with the department graduate office for additional details about filing fee status.

Dissertation Requirements

Near the end of their Ph.D. candidacy, students present the results of their dissertation research to the department as part of the department colloquium series or at a specially scheduled meeting. Each Ph.D. candidate is required to submit an abstract of the dissertation for distribution one week before the scheduled seminar date according to the following policy:

1. The student will prepare a dissertation summary, **signed by the dissertation adviser**, in a format that can be reproduced directly for immediate distribution. Sample summaries can be obtained from the graduate office, where the summaries should be submitted at least one week before the scheduled date of the colloquium.
2. The summary **should not exceed four pages**, including tables, figures, and references, and should be as concise and short as the nature of the research and the resourcefulness of the student permit.
3. The summary will be distributed to the faculty, and copies will be available in the graduate office for those students who have a particular interest. The student's final obligation to the University and to those who helped and sponsored him or her is to produce the dissertation itself and the resulting manuscript(s) in a form suitable for publication. This obligation is to be met before the student's departure from Berkeley. Copies of the dissertation must be provided for the research adviser and for the Graduate Division. Requirements for production of the thesis or dissertation are set by Graduate Division and are quite specific. Guidelines can be found at the Graduate Division website.

*Summary of Initial GPCC Discussions on the Format and Content
Of the Written Part of the Qualifying Exam*

General Comments

- a) The structure and format of the technical manuscript should reflect those of appropriate leading journals in the areas of research; the format should be decided through consultations between the graduate student and the research adviser, within the guidelines provided below.
- b) The audience for both the technical manuscript and for the subsequent oral exam is an examining committee composed of experts in the specific problem and approach, but also of relative outsiders that may not share the detailed knowledge of the experts about the methodology or the language of the specific problem.
- c) The technical manuscript and the oral exam provide the most significant opportunities for the qualifying exam committee to judge the likelihood of ultimate success in attaining a PhD degree.
- d) Ale GPCC has discussed at some length the role of the adviser in the preparation of the technical manuscript. We have concluded that adviser-student relationships and mode of interaction in the process of preparing the manuscript should remain flexible in order to accommodate the temperaments and needs of the individuals involved and in order to avoid the establishment of unenforceable guidelines. The participation of the adviser in the preparation, organization, and “polishing” of the manuscript is therefore left to the discretion of the student and the research adviser. While it is possible that extreme deviations in adviser involvement from the mean may influence the “accuracy” of an assessment based on the written part of the exam, we expect that such extremes and any “inaccuracies” will become apparent during the oral exam. In the oral exam, the student will be confronted with questions that require evidence of independent and clear thought and of thorough knowledge about the research topic.
- e) In the case of failing an exam, the technical manuscript, after modification based on comments by the adviser and by the exam committee, should become the basis for the thesis required for the M.S. degree. The document should be prepared so that the scope and the treatment of the material can be readily modified in the order to satisfy the formal thesis requirements for the M.S. degree.

Format and Content of Technical Manuscript (*guidelines are provided for section lengths; only abstract and total manuscript have firm length restrictions*). **Please use 12 point font throughout.**

The title page should identify the document as “Qualifying Exam Manuscript” with name, title and exam date.

1. *Summary/Abstract (maximum one page, single spaced)*

This section should provide a self-contained summary of the results and of the problem being addressed. It should emphasize accomplishments and not the performance of intermediate tasks required to reach such accomplishments.

This section should answer the following questions clearly and concisely about the research performed and the research planned:

- a) What is new about the work?
- b) Why is the work/problem important? Why is it scientifically interesting and challenging?
- c) What is the approach and why is it appropriate and novel?
- d) What have you accomplished?
- e) How has your work advanced knowledge in this area? How do you plan to proceed?
How does the research fit in the context of larger and more general problems in this research area?

2. *Introduction*

The objectives of this section are to:

- a) Bring experts and non-experts in the examination committee to the level of knowledge required to judge the quality and progress of the research through a concise description of the specific problem and of the general research/technology area.
- b) Place the solution of the problem accurately within the context of what is known from previous work and of what is required in order to advance to the next step of knowledge or system performance.
- c) Briefly state the objectives of the proposed research.
- d) Describe briefly the general approach that has been (and/or will be) taken to advance the chosen area during the course of the Ph.D. research, with emphasis on the appropriateness and novelty of the approach.

3. *Methods*

This section should describe the methods used (and to be used) in conducting research. The level of detail should be sufficient to judge the appropriateness, novelty, and accuracy of the methods. In contrast with a journal publication, details need not reach the level required for an independent researcher to reproduce the results.

The following comments are intended as guidance for the questions that should be answered and for the level of detail required in this section.

- a) What is measured? Why is it measured? How is it measured? Why is it the right thing to measure? (Where “measured” appears in this document, it should be replaced with the appropriate description, e.g., “stimulated,” or “described” for non-experiment projects.)
- b) What is unique about the measurement? What are possible experiment artifacts? How are they ruled out? How does one translate the measurement into knowledge about the fundamental properties of the system under study (i.e., how are the data “analyzed” and what are the “interpretation” protocols)?
- c) What is the accuracy/reproducibility of the measurements? How was it established?
- d) A diagram and a short description of apparatus/stimulation may be a sufficient description for many projects. For other projects, the development of an experimental set-up or a stimulation method may be the objective itself; in those cases, and after approval by the research adviser, the length of this section and the level of detail provided may be significantly expanded. In projects addressing the development of a tool, the results/discussion section should contain many of the details that would be contained in the Methods section when more established (“routine”) methods are used. In the infrequent case where equipment design and construction are the most significant part of the accomplishments for the first two years, the student should seek the advice of the chair of the examining committee about the best approach to the presentation of the material well in advance of all deadlines.

4. *Results/Discussions*

This section should describe in detail the accomplishments of the research using a level of detail and rigor similar to what would be expected for a publishable manuscript, although clearly the level of output and the generality of the results will evolve in the remaining years of graduate research. It should set the basis for the section that will immediately follow, which contains a more detailed description of such research plans. This section should show that the research is progressing in a natural and logical manner towards the objectives described in the abstract and in the introduction.

The contents of this section should represent a factual description of all results relevant to the advancement of the question posed and not a catalog of all experiments performed. The appropriateness of the experiments, the quality and rigor of the results, and the validity of the interpretations (not the number of experiments) will be used as the relevant criteria in order to judge significant progress towards a PhD degree.

In this section, the student should think carefully about the most effective presentation of the results in either table or figure format, while avoiding redundant or inefficiently presented technical details or data. Figures and tables should be included within the text at a point as close as possible to where they are first mentioned.

In general, the combination of research results with the discussion of such results will lead to a more concise and lucid manuscript than separate sections describing the results and their

interpretation. The student, however, must distinguish clearly between the factual descriptions of observed phenomena and the interpretation of these phenomena using heuristic or mathematical constructs.

We stress that the novelty of the approach, the relevance of the results to the solution of the proposed ‘problem,’ and the rigor, accuracy, and validity of the results and models will be used as the criteria for a passing exam.

5. Conclusions and Future Plans/Timelines

This section should summarize the status of the research and describe in some detail the remaining tasks that must be completed in order to complete the dissertation. Such tasks should be described in parallel with a timeline that matches each task to its expected completion date. The level of detail about the proposed activities should be highest for the most immediate tasks and descriptions can become more diffuse for those tasks requiring significant time and effort for completion or where their definition and execution is contingent upon the successful completion of intermediate tasks. Decision points add critical intermediate tasks that can lead to branching paths along the research project (in either approach or objectives) and should be clearly identified and discussed in this section.

It is intended that this section will become the benchmark against which future progress will be measured using our yearly progress evaluation protocols and forms. Questions that must be answered in this section include:

- a) What tasks will you be implementing within the next six months. Provide enough detail such that it is clear to the committee members how you have estimated this time-table.
- b) What will you do in the following six months?
- c) How does the outcome of the tasks planned for the first six months affect the tasks proposed for the second six months? Clearly identify the decision points and critical intermediate tasks which may lead to branching points along your project, and how each would affect the time-table and subsequent plans.
- d) What will you do in the subsequent year? Once again, clearly identify the decision points and critical intermediate tasks which may lead to branching points along your project, and how each would affect the time-table and subsequent plans.

6. References

The number and type of references should be chosen wisely with the purpose of establishing the state of the art in the research area. There should be a judicious balance between the most relevant references in the historical context of the area and the most recent research that has significantly advanced knowledge in the area of the research. Old references that have stood the test of the time are appropriate, even if “dated.” Recent citations that do not contribute significantly to the solution of the research problem should be excluded.

CHECKLIST FOR COMPLETION OF THESIS MASTERS DEGREE**1. Registration Requirements***Every semester:*

Department colloquium (1 units)

Seminar with adviser (1 units)

Research with adviser (variable up to 12 units)

2. Coursework*Complete Graduate Chemical Engineering Courses (9 units)*

Complete Electives: Upper Division or Graduate Courses Approved by Academic Adviser (5 units)

3. Annual Progress Reports (June)

Meet with research adviser and thesis committee members, and submit annual progress report

4. Advance to Candidacy for the Masters Degree___ Apply to advance to candidacy in the *semester in which coursework is to be completed, before the 5th week of the semester***5. Apply for Filing Fee Status if Appropriate****6. File Thesis with Graduate Degrees, 318 Sproul Hall**See website for guidelines <http://www.grad.berkeley.edu/current/index.shtml>**7. Check-out with Department Graduate Office**

___ Check-out form

___ College of Chemistry alumni questionnaire

___ GSAC survey

___ Copies of thesis for research adviser(s)

REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE (PLAN I THESIS)**Background**

New students are expected to possess a satisfactory background in areas covered by the following "core" Berkeley courses:

Chem 120A&B	Physical Chemistry
Chem 112A&B	Organic Chemistry
Math 1A&B	Calculus
ChE 140	Chemical Process Analysis
ChE 141	Thermodynamics
ChE 142	Kinetics and Reaction Engineering
ChE 150A&B	Transport Processes
ChE 154	Chemical Engineering Laboratory
ChE 157	Transport Processes Laboratory
ChE 160	Process Design
ChE 162	Process Control
EECS 40 or 100	Electrical Circuits or Electronics
Mat. Sci.	Materials Engineering

Students with obvious deficiencies will be asked to take the appropriate core coursework. Graduates with the M.S. must be competent at this level. In addition, background training in some of the areas covered by the following courses is strongly recommended.

ChE 170	Biochemical Engineering
ChE 171	Transport Phenomena
ChE 176	Electrochemical Processes
ChE C178	Polymers
ChE 179	Solid State Materials Devices

Course Load per Semester

All students must take a complete set of courses. This department considers this to be equivalent to 9 units of graduate work. When upper division courses are included in your program, the total number of units may exceed 9.

It is expected that a student will take three courses the first semester and two courses the second semester. This will complete the minimum course requirement in the first academic year to allow subsequent time for a concentrated effort on the research for the thesis.

Unit and Grade Requirements

1. At least 20 units must be earned.
2. The coursework must include at least 14 units of letter-graded courses, of which at least 9 units must be 200-level courses in chemical engineering. The remainder may be chosen from a wide variety of upper division undergraduate and graduate courses available in science, engineering, and business departments on campus, but must be approved by the master's academic adviser.
3. A total of 6 units of ChE 296, 298, 299, and other S/U courses may be counted toward the 20-unit requirement.
4. A GPA of 3.0 or higher is required to remain in good academic standing and for graduation. (A GPA of 3.1 or higher is required for a GSR appointment.)

Advancement to Candidacy

A thesis research M.S. student must be officially advanced to candidacy before the end of the fifth week of instruction in the semester during which he or she expects to file the theses. To become advanced, the student must have fulfilled the coursework requirements for the Plan I M.S. degree (courses in which the student is currently enrolled may be counted), and have selected the thesis committee (two faculty within the department and one faculty outside the department). The Application to Advance to Candidacy for the Master's Degree can be obtained from the department graduate office or the Graduate Division Degrees Unit in 318 Sproul Hall. There is no charge for advancement to candidacy for the master's degree.

Progress Reports

To assist in fulfilling degree requirements in reasonable conformity with the two-year normative time, the department makes a routine review of the student's research status at the end of the second semester of residence in the M.S. program and every year thereafter. At the end of the second semester in residence, the student submits a brief report describing the degree of completion of research, the tasks yet to be completed, any expected difficulties or delays, and a projected schedule indicating a calendar date for completion of the thesis to the head graduate adviser. The report must be signed by the research adviser.

Thesis Requirements

1. All Plan I Masters students must write a master's thesis.
2. The thesis topic is to be selected early in the first semester after the research adviser has been selected.

3. The thesis must be read and approved by the research adviser and two other faculty members, one of whom must be from outside the department.
4. The thesis must be filed before the degree can be received.

M.S. Program in Chemical Engineering for Students with a B.S. in a Different Field

It is expected that students entering the thesis research M.S. program will have completed an undergraduate program similar in scope to the B.S. program of this department. However, applications may be accepted from time to time from students with bachelor's degrees in other fields. Such students will work out a program of study with their academic adviser that will include the necessary background undergraduate courses. These courses will usually be Chemical Engineering 141, 142, 150A, 150B, and 160. Six units of these 100-level courses will be credited toward the 20 required for the M.S. in recognition of the student's training in another field. The additional time required over the normal program is approximately two semesters.

Residence Requirements

The normative time for M.S. students in Chemical Engineering (defined by Graduate Division) is 4 semesters. Our objectives are to have M.S. students complete their degrees in 4 semesters. Students and their research advisers will need to justify any extensions. With this in mind, the following stipend reduction schedules will apply to degree candidates:

degree program	beginning in semester	stipend reduction %
M.S.	6	10
M.S.	7	50
M.S.	8	100

Exceptions to the stipend reduction schedule will be considered by the Graduate Education Committee (GEC), who will consult with both the student and the thesis adviser. In some cases, the GEC may decide that the student is also responsible for the fees and tuition.

M.S. students at the end of their 4th semester must submit a statement to the GEC if they anticipate their degree will not be completed by the 5th semester. The statement should summarize progress to date (briefly, not like an annual progress report), state what needs to be done, outline the schedule for completion, and justify any extension beyond the stipend schedule indicated above. For example, switching research directors might be grounds for an extension.

Any petition should state what circumstances have arisen that make timely completion of the degree impossible and include a precise schedule of the postponed stipend reduction being

requested. There should be a separate letter from the research director giving his or her own perspective of how the problem arose and how a specific postponement is justified.

Filing Fee

The filing fee should be used only in accordance with university policy.

The student must be either registered or in filing fee status in order to file the thesis. The filing fee is paid in lieu of registration, and the student is considered to have withdrawn from the university. Under most circumstances, the research adviser can pay the filing fee and health insurance for the student. Filing fee status may be used only once in your graduate career at Berkeley, and the student must be readmitted to the university and re-registered and pay all fees if the thesis is not filed by the expiration of the filing fee period.

No thesis research M.S. student will receive a stipend in any semester subsequent to the semester in which the filing fee is used in the event that the thesis still has not been filed. After leaving the University, students are responsible for paying their own fees, whether these are the filing fee or regular fees on reinstatement.

RESOURCES FOR GRADUATE STUDENTS*

Bear Facts (<http://bearfacts.berkeley.edu/>) - online student portal for e-bill, unofficial transcripts, and student information.

Billing & Payment Services (<http://billing.berkeley.edu/>) – information about University loans and Campus Accounts Receivable System (CARS) accounts.

Berkeley Art Museum and Pacific Film Archive (<http://www.bampfa.berkeley.edu/>) – information on art exhibits, film screenings, and museum collections.

Berkeley International Office (<http://internationaloffice.berkeley.edu/>) – resources and advice on immigration, financial, and personal matters.

Calbears (<http://calbears.cstv.com/>) – official site of the California Golden Bears; includes team schedules and ticket information.

Campus Life and Leadership (<http://students.berkeley.edu/osl/osl.asp>.) – expert and hub for transformational student leadership. CLL is a source for student organizations and leadership programs. It is home to the Cal Corps Public Service Center, the Gender Equity Resource Center, and the Center for Student Conduct and Community Standards.

Career Center (<http://career.berkeley.edu/>) – sponsors workshops specifically for graduate students and offers Ph.D. career counseling services by appointment.

Child Care (Early Childhood Education Programs) (<http://www.housing.berkeley.edu/child/>) – information about campus child care programs.

Computing (<http://technology.berkeley.edu/student/>) – general information on computing services for students.

Counseling Services - University Health Services

(<http://www.uhs.berkeley.edu/students/counseling/>) – provides group and individual counseling for students on a variety of personal, academic, and career-related issues.

Disabled Students' Program (DSP) (<http://dsp.berkeley.edu/>) – offers services and resources for students with disabilities.

East Bay Regional Parks (<http://www.ebparks.org/>) – information about the many parks and outdoor activities right in our own backyard.

Electronic Funds Transfer (EFT) (<http://eftstudent.berkeley.edu>)

Financial Aid Office (FAO) (<http://students.berkeley.edu/finaid/>) – important information for graduate students about student loans and federal student aid.

* Some resource links and text are taken from the *Guide to Graduate Policy* document produced by the Graduate Division.

Graduate Assembly (GA) (<http://ga.berkeley.edu/>) – graduate student arm of the student government on campus.

Graduate Social Club (<http://gsc.berkeley.edu/>) – events for grad students to meet and mingle.

Graduate Student Instructor (GSI) Teaching & Resource Center (<http://gsi.berkeley.edu>) - information on requirements for first time GSIs, schedules for workshops on various topics, portal for online ethics course.

Housing (Cal Rentals) (<https://calrentals.housing.berkeley.edu/index.htm>) – Berkeley’s own rental listings unit and resource for finding local housing.

Libraries (<http://www.lib.berkeley.edu/>) – home page for the University Library system.

Library Research Services for Graduate Students

(http://www.lib.berkeley.edu/services/for_users/grad_students.html) – UC Berkeley Library resources for graduate students.

Office of the Registrar (OAR) (<http://registrar.berkeley.edu/>) – up-to-date information on registration fees, adding/dropping a class, Tele-BEARS, Bear Facts, residency, grades, and more.

Ombudsperson (642-5754) – neutral, confidential assistance in situations where you feel you have been treated unfairly or need help with a procedural or academic problem.

Parking & Transportation (<http://pt.berkeley.edu/>) – information about parking permits, campus shuttles, and alternative transportation.

Police (<http://police.berkeley.edu/>) – information about campus safety programs, night escort service, and emergency preparedness.

Recreational Sports Facility (RSF) (<http://calbears.berkeley.edu/>) – information on membership, fitness classes, sports facilities, personal training, and more.

Residency (<http://registrar.berkeley.edu/Residency/legalinfo.html>) – information on CA residency and how to petition to be a CA resident.

Resource (<http://resource.berkeley.edu/>) – online guide for new Berkeley students with lots of information about shopping, dining, recreation, nightlife, campus organizations, and more.

Student Calendar (<http://registrar.berkeley.edu/GeneralInfo/stucal.html>) – important dates for filing and registration.

The Parents Network (<http://parents.berkeley.edu/>) – newsletters, recommendations, and advice for student parents.

University Health Services (UHS) (<http://www.uhs.berkeley.edu/>) – information about student medical care, counseling, psychological services, insurance, workshops, and more.

511 Transit (<http://www.511.org/>) – provides schedules for, and information about, major Bay Area public transportation systems, including BART, San Francisco MUNI, Caltrain, and AC Transit.