

**DEPARTMENT OF CHEMICAL ENGINEERING
WEST VIRGINIA UNIVERSITY**

GUIDE TO GRADUATE STUDY FOR THE PHD DEGREE

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NOTE: Please direct any specific questions you have about the PhD program to your Research Advisor or the Graduate Program Committee.

I. PROGRAM INTRODUCTION AND OVERVIEW

The College of Engineering and Mineral Resources (CEMR) of West Virginia University is authorized to admit qualified graduate students to an Interdisciplinary Program leading to the degree of Doctor of Philosophy in Engineering. Students should read the College of Engineering and Mineral Resources Guidelines which describe the detailed minimum requirements for the above degree. The Chemical Engineering departmental guidelines, which exceed these minimum requirements in several important areas, are discussed below.

Applicants for admission to the program should have an earned B.S. or MS degree in Chemical Engineering from an accredited institution. While it is possible for students with degrees in other engineering or science fields to enroll directly in the PhD program, it is usually required for them to earn a Master of Science in Engineering (MSE) degree first.

A typical PhD program in Chemical Engineering involves an approved plan of study consisting of a minimum of 36 course credit hours beyond the B.S. degree or a minimum of 12-18 course credit hours beyond the MS degree. The plan of study is selected by the student, the Research Advisor, and the Advisory and Examining Committee (AEC) subject to approval by the Academic Advisor for the Chemical Engineering Department to fit the individual interests and objectives of the student. Each plan of study and AEC must be approved by the department and college as soon as possible after the student enters the department, but no later than the end of the second semester of attendance by the student. There is a 9 credit hour sequence of ChE course work required for students entering with B.S. degrees. Master of Science students who enter the PhD program, and who have not formally satisfied these ChE course requirements, will be required to make up any deficiencies. A minor area of study is required.

To become a successful Candidate for the PhD degree a student is required to complete all course work with a 3.0/4.0 GPA or better, all ChE course work with a 3.0 GPA or better, pass a Qualifying Examination and Original Research Proposition, and have an acceptable Dissertation Research Proposal. A PhD degree can not be awarded until at least two months after admission to Candidacy.

The research work for the doctoral dissertation should represent a significant contribution to the advancement of the art or science of engineering. It is anticipated that the work leading to the completion of the dissertation would require a minimum of 24 hours in research dissertation credits. It may entail a fundamental investigation into a specialized area, or a broad and comprehensive study of a novel system design. In either case, a high degree of creative and original effort is required to meet the standards of acceptability.

For a variety of reasons, some changes to the program guidelines may be deemed necessary during any given academic year. The Graduate Program Committee (GPC), which has a graduate student representative elected by fellow graduate students, will evaluate the necessity for any modifications and make recommendations to the faculty for their timely introduction into the program. The faculty will inform students in writing about any such changes.

II. ADMISSION TO DOCTORAL WORK

The department will consider a student's application for admission to doctoral work on the basis of the following criteria:

- a. A B.S. in an accredited Chemical Engineering program or a recognized international program in Chemical Engineering; or a MS/MSE
- b. A completed application submitted to the WVU Admissions Office; official transcripts of all previous college course work must be supplied,
- c. Grade point average (GPA) exceeding 3.0/4.0 in undergraduate and graduate courses,
- d. Performance on MS thesis, if one was written,
- e. Three letters of recommendation
- f. TOEFL scores of 550 or better for non-U.S. degree entrants for whom English is not the national language, and
- g. GRE scores, if requested by the department.

Students admitted will be classified as regular graduate students only. Provisional students, defined as applicants having a GPA less than 3.0/4.0, will not be admitted to the PhD program.

III. CHEMICAL ENGINEERING PhD PROGRAM REQUIREMENTS

A doctoral degree student in chemical engineering must satisfy the requirements shown below. Appendix A contains a list of some suggested courses approved for graduate study. Transfer credit is left to the discretion of the student's AEC and Academic Advisor, but cannot exceed a maximum of twelve (12) semester hours from other institutions (form available online – see section XVII for URL). Bachelor of Science students entering the PhD program must complete the same required Ch.E. courses as for the MS program.

1. ChE 615 - Transport Phenomena (3 credits)
2. ChE 620 - Thermodynamics (3 credits)
3. ChE 625 - Chemical Reaction Engineering (3 credits)

MS students who have not satisfied these course requirements will also be required to take these courses. Two semesters of full-time attendance on campus are required, each consisting of a minimum of 9 credit hours. No more than 15 hours of graduate courses in any one semester may be carried by a student. No more than 12 credits total may be earned during the two summer enrollment periods. The total program must meet the following requirements:

- a. A minimum of 36 course credit hours at the 500 - 700 level if admission to the PhD program is directly after the BSChE degree, and a minimum of 18 course credit hours at the 500 - 700 level if the student has a MS in chemical engineering from WVU or another institution,
- b. Completion of a minor, consisting of a minimum of 9 semester hours of a coherent set of courses taken outside the department. These courses may be related to the major

- research area. Non-technical courses may be considered only under exceptional circumstances. All courses must be approved by the AEC and Academic Advisor.
- c. A plan of study approved by the AEC, Department, and Dean's Office,
 - d. Completion of graduate courses with an overall course work average of 3.0 or better (exclusive of research credits) and completion of all ChE courses with an overall GPA of 3.0 (exclusive of research credits),
 - e. Pass the PhD Qualifying Examination,
 - f. Successful completion of an Original Research Proposition on a topic unrelated to the student's major area of research,
 - g. Acceptance of a written dissertation research proposal and successful oral presentation of this proposal to the AEC,
 - h. A minimum of 24 graduate credits in dissertation research,
 - i. Completion of one credit hour of chemical engineering seminar (ChE 796) each semester,
 - j. Acceptance of a completed dissertation in the major field, embodying the results of original research and giving evidence of being a potentially publishable contribution to knowledge,
 - k. Submission of a manuscript on the dissertation research to the AEC, and
 - l. Completion of the program in a maximum of 7 years total from time of initial enrollment.

IV. REGULAR GRADUATE STATUS

To remain in good standing, a regular student must obtain a minimum 3.0 GPA after the first nine (9) hours of graduate study and maintain at least this average throughout the remaining time enrolled in graduate work. A full-time student failing to achieve or maintain this standard will be placed on probation. A probationary student who cannot attain the required average will be suspended from the college for one semester. In addition, regular or probationary students who obtain grades of D or F in one-half or more of their courses during any enrollment period will be suspended from the College for one semester. A suspended graduate student may be readmitted only once, and must achieve a GPA of 3.0 or better in each semester following readmission until a 3.0 GPA is reached. A graduate student suspended from the College can apply for reinstatement only by direct petition to the Dean.

All graduate courses taken will count in computing the student's overall GPA. The grade of D or F is not counted toward completion of degree requirements and therefore that course must be retaken. For purposes of computing the ChE GPA the second grade obtained will replace the D or F. Only in the most exceptional cases will an alternate procedure suitable for the case be permitted, provided such a procedure has the approval of the course instructor, the student's Research Advisor, and the Department Chairman.

The grade of S causes no grade value and is not used in calculation of the GPA. The grade of U carries a zero grade point and is used in the calculation of the GPA. Therefore, the U grade would be treated the same as a grade of F.

Specific approval is required by the Academic Advisor to count a pass/fail course toward a student's plan of study, and only if this course is not offered for a letter grade.

V. FINANCIAL AID AVAILABLE

Financial assistance for graduate students in the Chemical Engineering program is available from the sources listed below.

Research Assistantships: Appointments are usually available for the student to participate in particular research projects which may often serve as dissertation research topics. A tuition scholarship is usually included. During the academic year, research assistants devote nominally one-half of their weekly effort to the dissertation research project. More time is expected to be devoted to research during the summer.

Teaching Assistantships: Some teaching assistantships may be available to qualified individuals. During the academic year the student is expected to devote half-time to assisting a faculty member in a course. This is in addition to time spent on research for the graduate degree that the student is pursuing.

Fellowships: These are special forms of scholarship which are sponsored by industry or government agencies. Fellowships may be granted for support of specified research, or in some cases may be unrestricted.

VI. FINANCIAL SUPPORT POLICY

It is the intention of the Department to support students receiving aid as long as they continue to demonstrate satisfactory academic performance and progress. Supported students must complete work assignments in a satisfactory manner as judged by the faculty. However, this general statement of intent is subject to the following specific regulations adopted by the faculty:

1. Students supported are required to register for at least 12 hours each semester including research and excluding ChE 796. Students with a Master's degree should expect to take 3 courses the first semester, and complete their course requirements within three semesters. Students with only a Bachelor's degree are required to take 4 courses in their first semester, and should expect to complete their course requirements within two years.
2. It is understood that any suspension from the graduate program also involves loss of financial support.
3. Financial aid awarded to doctoral students shall not exceed four calendar years in duration for those entering the program with a BS degree, or three calendar years in duration for those entering the program with a MS degree. Petitions to set aside this regulation will be approved only under exceptional circumstances.

A student may, at any time, with the approval of the Research Advisor, request an exception to these provisions by submitting a written petition to the Academic Advisor indicating reasons why he/she believes the circumstances are exceptional. The final decision on such provisions will be made by the entire faculty.

Students should recognize that the awarding of financial aid, either as a continuation of previous support or as a new award, is subject to the availability of funds and any other restrictions which may apply. Finally, it should be recognized that departmental decisions on financial aid are based on consideration of all aspects of each individual situation within the framework of the guidelines indicated above. In the final analysis, the best assurance that a student has regarding financial support is to devote his/her best effort towards the completion of degree objectives in a timely fashion.

VII. DISSERTATION RESEARCH SELECTION

Selection of a doctoral dissertation topic and Research Advisor is done as follows. It is expected that students with guaranteed financial aid will select funded topics of interest from at least three different professors and arrange meetings to discuss each topic on an individual basis. The purpose of such meetings is twofold: (1) it serves to identify areas of mutual interest, and (2) it provides both the professor and student a chance to gauge their respective abilities to collaborate with one another to solve a problem which will constitute the dissertation. This is clearly a matter of utmost importance, hence more than one meeting may be desirable on any one topic. Since the situation can become somewhat competitive, especially for the case of extramurally funded research, it will be necessary for each student to provide the Chair with a list of topics and professors, in priority order. This should be done as soon as possible after thoroughly exploring their research interests as detailed above, but within 4 weeks after the semester has begun.

Students will be notified of dissertation assignments as early as possible but within 5 weeks after the semester begins. The department will strive to match up students and Research Advisors based upon first choices. In some cases, however, when there is competition for a particular topic, this may not always be feasible.

VIII. ADVISORY AND EXAMINING COMMITTEE (AEC)

The student, with input from the department and the Research Advisor, will form an Advisory and Examining Committee (AEC) consisting of a minimum of five members as soon as possible after beginning PhD study. Three members must be Chemical Engineering faculty, one of the members of the AEC must be approved by the Dean and one by the Department Chair. Two of the members of the AEC must be from outside the Department. The AEC, chaired by the student's research advisor, must be formed by the end of the second semester of attendance by the student, and will have an integral role in the student's PhD program. The role of the Academic Advisor for the department is to have primary control over course election, with appropriate input from the AEC, until the student becomes a PhD Candidate.

A Plan of Study (form available online – see section XVII for URL) must be prepared by the student and his/her AEC. This plan must be approved by the student, AEC, Academic Advisor, Department Chair, and the CEMR Dean by the end of the second semester. This plan also must include a brief, preliminary dissertation research proposal approved by the AEC.

IX. PhD QUALIFYING EXAM

A PhD student must pass the Chemical Engineering PhD Qualifying Examination. This exam will be given regularly in early May each year. All students are required to take the Qualifying Exam no later than one year after they enter the PhD program. In the event of failure, a student will be permitted a second try which will be given in August. Graduate students completing Master's degree programs at WVU, and who plan to continue on for the PhD, may take this examination near the end of their MS program at a time when the exams are regularly scheduled. Passing the Qualifying Examination does not by itself guarantee admission into the PhD program for such students.

This examination will test the student's knowledge of the theoretical principles of the physical and chemical sciences which are of fundamental significance to the field of Chemical Engineering. The exam is structured so that there are open book sections in Transport Phenomena, Thermodynamics, and Reaction Engineering and a closed-book Engineering Science section. See Appendix B for more details on the PhD Qualifying Examination.

X. ORIGINAL RESEARCH PROPOSITION

Within 6 months after passing the Qualifying Examination or entering the PhD program, whichever is the later, the student must submit to the Chair of the Graduate Program Committee (GPC) a preliminary topic and explanatory paragraph on ideas for an original research proposition (ORP). The ORP must be unrelated to the student's dissertation research and should include a literature survey to support the originality of the idea. The GPC, with the approval of the Department Chair, shall select a Research Proposition Committee (RPC) to examine the ORP. Membership on these Committees shall rotate through all members of the faculty, but an individual committee may add other faculty as needed to assess the student's proposition. Research Advisors may not serve as chairmen of RPCs during their own student's proposition defense.

The committee will determine within 2 weeks whether the proposition is appropriate. If the idea is given majority approval by the committee, the student proceeds to develop the idea and prepare a written proposal, based on the format specified in Appendix C.

One month after committee approval, the student submits the original proposal to the GPC and copies of the proposal to the RPC. The RPC will then review the ORP, and schedule an oral presentation within 2 weeks. A student must defend the research proposition to the same RPC that approved the preliminary proposal. In the case of an unsuccessful defense, the student

will be allowed one opportunity within six months to defend the same or another research proposition, as recommended by the RPC.

The ORP is the intellectual property of the student.

XI. DISSERTATION RESEARCH PROPOSAL

The student must submit a copy of a formal research proposal to all AEC members for their critical evaluation. All students must complete this written proposal and an oral presentation on their research within a maximum of one semester after passing the PhD Qualifying Examination or entering the PhD program, whichever is later. When the written proposal is tentatively accepted by the AEC, the student will schedule a formal presentation and discussion of the research proposal by the student. This is an open oral inquiry into the technical merit of the proposed research.

The detailed written statement on the proposed dissertation should outline the work the student proposes to do. It need not be extensive but should contain: (a) a statement of the problem; (b) a short background of the topic of interest; (c) the plan of approach on the research; (d) a specific statement of the objectives to be accomplished during the dissertation research; (e) an estimate of the supplies and equipment required; and (f) a statement addressing the safety requirements which must be met in order to conduct the research properly, including any specific safety provisions which must be considered. This is clearly a matter of utmost importance to the safety of all personnel. In addition, a bibliography of pertinent literature should accompany the proposal. The proposal should be written in such a manner as to convince those reading it of the desirability for doing the work, and of the adequacy of the student's preparation for the research.

Oral presentations shall be conducted such that each member of the student's AEC first provides the student with a brief, written evaluation of the dissertation proposal prior to the oral examination. This evaluation should include: (a) a statement of general acceptance or rejection of the proposal; (b) a brief outline for recommended modifications or additions; and (c) specific technical areas in which the AEC member plans to examine the student during the oral examination. The student shall schedule the oral presentation to be held no later than 30 days from initial receipt of the proposal by the AEC members.

The AEC shall deliberate in private to evaluate the merit of the research proposal, and shall then inform the student of the decision. The AEC shall communicate this same decision in writing to the Academic Advisor, Department Chair and Dean's Office. If necessary, a recommendation procedure for re-evaluation and re-examination must be made by the AEC.

During the course of the dissertation research, it is the responsibility of the student and Research Advisor to keep the entire AEC informed of progress made. Likewise, each AEC member is expected to maintain an active interest in the student's work. To maintain this necessary communication, it is required that: (a) students submit each academic semester a one-page typewritten summary of their research progress and future plans to each AEC member and to the Academic Advisor for inclusion in the student's records; and (b) the AEC meet formally

with the student at least twice each academic year to review progress and to re-evaluate directions and objectives as deemed necessary. It also would be useful for the AEC to meet and evaluate the student's data and results before the student begins writing the dissertation. A minimum of two semesters must pass between successful completion of the research proposal and awarding of the PhD degree.

XII. CANDIDACY REQUIREMENTS

A graduate student who has successfully completed course requirements with a 3.0 GPA, passed the Chemical Engineering Qualifying Examination, and who has received departmental acceptance of an Original Research Proposition and Dissertation Research Proposal, is considered to be a Candidate for the PhD degree. A student enrolled in the PhD program is expected to move expeditiously toward completion of the Candidacy procedure. A student may not present a dissertation for the PhD degree until at least 2 months after formal admission to Candidacy by the Department. Upon notice of Candidacy, the advising of the student formally becomes the responsibility of the Research Advisor. The Research Advisor must submit a copy of the Candidate's approved Final Plan of Study and Research Proposal to the Academic Advisor and Dean's Office at the time of certifying the student as a Candidate. (Form available online). The Candidacy will automatically terminate if the student fails to register for at least 1 credit hour during a calendar year. To be reinstated in the PhD program, such a student would need either to repeat the Candidacy procedure or, in exceptional circumstances, to petition the Department in writing through the Academic Advisor.

XIII. SUBMISSION OF DISSERTATION

The Candidate's final examination process involves submission of a typewritten copy of the dissertation to each AEC member for their critical evaluation. The final draft copies of the dissertation should be submitted not less than five weeks before Commencement. The dissertation must be typed according to the University guidelines for dissertations. The AEC will evaluate and review the written dissertation, and the student will schedule an oral presentation and defense of the dissertation. Normally a Candidate should expect that if more than minor changes are required by the AEC in the final draft, it will be deemed unacceptable. Three weeks lead time must be allowed after the AEC receives the final draft and before the oral exam is scheduled, in order to permit the AEC ample opportunity to review the dissertation and to give the student time to prepare for the oral defense.

XIV. FINAL DISSERTATION ORAL DEFENSE

A request for the final examination (Form available online) must be made to the Dean's Office in the last semester at least 4 weeks before Commencement. Students must be registered in the semester they plan to graduate. Approval by the Dean's Office should follow no later than 1 week from the request, and will be signified by the return of the request form from the Dean's Office to the Academic Advisor. No oral examination may be given until both the Academic and Research Advisors receive the student's signed form from the Dean's Office.

Final oral examinations are given at least 2 weeks prior to Commencement. If the final examinations are given on the 14th day before Commencement, the results, through the return of the request form, must be delivered to the Dean's Office in person on the same day.

Candidates for the doctoral degree will be examined on their research work by the AEC and others present. The examination will take the format of an open seminar which all members of the University community may attend. At this examination, the Candidate is expected to defend successfully the work embodied in the submitted dissertation. The Candidate may be questioned on specialized topics related to the dissertation, and competency in Chemical Engineering.

The dissertation cannot be formally accepted until after this presentation. Only members of the AEC may participate in the final evaluation of the student's performance and the merits of the research. Successful completion of the PhD requirements requires that the AEC approve both the dissertation and final oral examination. Only one dissenting vote from the AEC will be permitted; otherwise, appropriate modification and re-examination of the Candidate is necessary.

XV. SUBMISSION OF MANUSCRIPT TO AEC

In order to complete graduation requirements, a Candidate must submit a typewritten manuscript to the AEC. This manuscript should be in a format deemed acceptable by the Research Advisor, for submission to a peer-reviewed journal. A paper already submitted or published on this research will satisfy this requirement. The Department considers this manuscript a very realistic expectation, since the PhD degree is primarily a research degree that embodies the results of an extensive research proposition and represents a significant contribution to the scientific literature. It is expected that the student and the Research Advisor will continue to collaborate closely after graduation to submit the manuscript for publication in a peer-reviewed journal.

XVI. FINAL APPROVAL

To graduate, the student must deliver to the Dean's Office two (2) bound typewritten and signed copies of the dissertation at least 3 days before Commencement. In addition, one bound copy is required for the Department and one each for the Research Advisor and AEC members. The costs involved in making copies of the dissertation, and in binding these copies are the responsibility of the student. Students should be aware that at least one week is needed for binding copies of the dissertation and that the University does not consider receipts for binding acceptable proof of completed dissertations.

Final approval for graduation will not be given until all keys, tools, equipment, etc. are returned in good order to the shop and Department. Also, any equipment that will not be used for further experimentation must be dismantled and the laboratory area(s) cleaned. The Department Chair will withhold final approval for graduation until these important items are satisfied.

XVII. FORMS

All required forms are available online at
<http://www.cemr.wvu.edu/studentservices/forms/index.php>

APPENDIX A

Some Suggested Courses for Graduate Level Study (check online Departmental course catalogues for additions and deletions)

Chemistry

- 401 - Chemical Literature
- 411 - Intermediate Analytical Chemistry
- 444 - Colloid and Surface Chemistry
- 532 - Advanced Organic Chemistry II

Civil Engineering

- 540 - Sanitary Chemistry and Biology
- 546 - Principles of Biological Waste Treatment
- 549 - Solid Waste Disposal
- 553 - Advanced Finite Element Methods
- 742 - Water Treatment Theory
- 744 - Industrial and Advanced Waste Treatment

Industrial Engineering

- 525 - Engineering Management
- 677 - Advanced Engineering Economy

Mathematics

- 420 - Introduction to Numerical Analysis I
- 421 - Introduction to Numerical Analysis II
- 441 - Applied Linear Algebra
- 451 - Introduction to Real Analysis I
- 452 - Introduction to Real Analysis II
- 456 - Complex Variables II
- 465 - Partial Differential Equations II
- 534 - Linear Algebra II
- 557 - Calculus of Variations II
- 564 - Intermediate Differential Equations II
- 567 - Advanced Calculus I
- 568 - Advanced Calculus II
- 753 - Special Function I, II

Mechanical & Aerospace Engineering

- 423 - Heat Transfer
- 424 - Application in Heat Transfer
- 473 - Bioengineering II
- 515 - Analytical Methods in Engineering I
- 531 - Fluid Mechanics I
- 621 - Advanced Thermodynamics I
- 623 - Conduction Heat Transfer
- 624 - Convection Heat Transfer
- 625 - Radiation Heat Transfer
- 660 - Controls in Mechanical Engineering
- 731 - Fundamentals of Turbulent Flow
- 721 - Fundamentals of Combustion

Physics

- 451 - Introductory Quantum Mechanics I
- 611 - Mathematics for Physicists and Engineers
- 651 - Quantum Mechanics I
- 725 - Advanced Atomic and Molecular Physics

APPENDIX B

PhD Qualifying Examination Procedures

The following format and procedures for the administration of the PhD Qualifying Examination have been instituted by the Department of Chemical Engineering beginning July 1, 1984.

A. Topics Covered

Day 1: Transport Phenomena, open book, 9 am-12 noon, (3 hrs)	20 pts
Day 1: Thermodynamics, open book, 1-2:30 pm (1 ½ hrs)	10 pts
Day 2: Reaction Engineering, open book, 9-10:30 am (1 ½ hrs)	10 pts
Day 2: Basic Concepts in Engineering Science, closed book, 1-2:30 pm (1 ½ hrs)	10 pts

B. To Pass the Exam Requires:

1. A minimum grade of 4 on each section (8 for Transport Phenomena) using the 0-10 grading scale shown below; and
2. A minimum of 30 points out of 50 points total or 60% overall

C. Grading Scale:

- 0 - no work
- 2 - little correct work
- 4 - some concepts correct but major errors
- 6 - general approach acceptable but fundamental errors
- 8 - major concepts correct but minor errors
- 10 - complete and correct

D. Departmental Policy and Procedures:

1. Two coordinators for each exam, with one person rotating out each time to be replaced by another faculty person.
2. Over a few year period of time, all faculty are expected to be involved in making up and grading exam questions.
3. Problems can cover both undergraduate and/or graduate material.
4. Questions for Reaction Engineering and Thermodynamics could be prepared by 1 or more faculty, but the Transport Phenomena section should involve at least 2 faculty. The Basic Concepts questions should be made up by a group of 2-4 faculty not involved in the other three sections tested.
5. The Transport Phenomena section must cover a minimum of two of the three transport areas.
6. Each section can consist of one large or several smaller problems, and students may or may not have a choice on problems.

7. Questions on each section can be weighted as desired by faculty involved in making up that section of the exam. This weighting factor will be specified on the exam.
8. All exam questions should be made up such that students are given sufficient time to do the problems in the allotted time for that section.
9. The Basic Concepts section is closed book and can be composed of a number of small problems (descriptive, conceptual, or calculational in nature) or a fewer number of larger problems. This is determined by faculty involved in that section. As much as possible, questions emphasized in this section should attempt to cover engineering science areas not tested in sections 1-3.
10. On the closed book section of the exam, it is necessary to provide the necessary data or other information to make problems complete.
11. Students do not know faculty composition for each section, so as to help minimize stereotyping or identifying a particular person or course with each section.
12. The Qualifying Examination will be offered regularly in May one week after final exams. It will be offered in August, one week before classes begin, only for students who did not pass the exam in May.
13. A student who passes the exam overall but who fails only one section (i.e. Thermodynamics, Reaction Engineering, Transport Phenomena, Basic Concepts) will be given the opportunity to be tested in that section using the same format, without retaking the entire Qualifying Examination. The student must get a minimum of 40% in the section retaken to pass the Qualifying Examination.
14. Students who fail more than one section or who fail to get 60% overall must take the entire make-up Qualifying Examination.
15. The individual sections to be retaken will be the appropriate sections of the entire make-up Qualifying Examination.

APPENDIX C

Guidelines for Preparation of Original Research Propositions*

The Proposal

The Original Research Proposition (ORP) should present (1) the objectives and scientific significance of the proposed work; and (2) the suitability of the methods to be employed. It should present the scientific merit of the proposed project clearly and convincingly, and should be prepared with the care and thoroughness of a paper submitted for publication. The ORP should be reviewed carefully to ensure that all essential data are included or summarized, unless they are readily available in published literature.

What to Submit

The ORP should cover the points discussed in the following paragraphs insofar as they are applicable. The proposition must be typewritten and must not exceed 15 double-spaced pages, excluding graphs, tables and figures. The original signed copy, and each of three copies, should be printed only on one side of each sheet. Each copy of the ORP should be stapled in the upper left-hand corner, but otherwise unbound, double-spaced, with pages numbered at the bottom and a 1-inch margin at the top. The three copies of the ORP should be submitted to the Chair of the RPC for distribution to the committee. The original signed copy should be given to the GPC chair who will place it in the student's file. Copies of any appendices, or the materials to be considered with the ORP, must be attached to the individual copies of the proposal. The contents of the ORP should be assembled in the following standard sequence: cover page, table of contents, project summary, project description, nomenclature (if necessary), and bibliography.

Cover Page

The title of the ORP should be brief, scientifically valid and intelligible to a scientifically literate reader.

Table of Contents

The table of contents should show the location of each section of the ORP as well as major subdivisions of the ORP.

Project Summary

The ORP must contain a 200-word summary of the proposed research. The summary should include a statement of the research objectives, scientific methods to be employed, and the significance of the proposed research to the advancement of scientific knowledge. It should be informative to other scientists in the same or related fields and, insofar as possible, understandable by a scientifically literate reader.

*Based on the NSF Guidelines (83-57): "Grants for Scientific and Engineering Research."

Project Description

The main body of the ORP should be a detailed statement of the work to be undertaken and should include: objectives and expected significance; relation to longer-term goals of the investigator's research; relation to the present state of knowledge in the field; and relation to work in progress elsewhere. The statement should outline the general plan of work, including the broad design of experiments to be undertaken or theory to be developed and an adequate description of experimental methods and procedures. Equations may be neatly hand-written into the text using a black pen.

Bibliography

A bibliography of pertinent literature cited in the proposal is required. It should be listed alphabetically or numerically, and the reference numbers listed parenthetically in the text, where appropriate.