

School of Biomedical Engineering

PH.D. COMPREHENSIVE EXAMINATION GUIDELINES

A. Purpose

The Comprehensive Examination is intended to ensure and demonstrate that candidates for the Ph.D. in Biomedical Engineering have the background preparation necessary for the successful completion and defense of the doctoral thesis. Its intent is *both* normative and pedagogical: serving as a mid-degree check on candidate's performance as appropriate to the doctoral degree, and assisting in best-possible preparation of the candidate to write and successfully defend an excellent Ph.D. thesis.

This examination will normally occur at about the 2-year point of the Ph.D. program, approximately one year after the thesis proposal. The candidate should demonstrate: (i) evidence of substantial understanding of the thesis subject area; (ii) evidence of good scholarship re: command of the literature, use of primary references, originality of written text and thought, intellectual honesty; (iii) appropriateness of answers given: i.e. at a level suitable to the doctoral degree (versus, say, the Master's or Bachelor's degree levels); (iv) ability to analyze the scientific/engineering literature *and* synthesize broader concepts derived thereupon; (v) grasp of the deeper issues in scientific and engineering knowledge surrounding the specific thesis topic and how they bear on the thesis.

B. Objectives

- (i) To ensure by written and oral examination that the candidate is in command of the multidisciplinary scientific/engineering literature broadly underpinning his/her thesis. If not, then areas of deficiency should be identified and the necessary remedial action taken to gain this knowledge.
- (ii) To provide a quality check on the candidate's approach to their science, and their ability to function at a high level of scholarship. The candidate should be functioning at a high level with the right motivations, intellectual rigor and honesty, that typify the academic model for the highest degree the university awards.

C. Preparation of the Candidate

Approximately one year prior to the likely date of the examination (normally at one year into the program) the candidate should reach agreement with the Supervisory Committee on the core areas of multidisciplinary science/engineering that underlie the proposed thesis. Since the examination will take the form of five questions (see below), it would be appropriate to ***identify five (respective) broad areas for intensive study*** of the literature prior to the examination. A suitable time point for this to occur would be following the successful presentation of the thesis proposal to the committee. Please see Figure 1 on the following page.

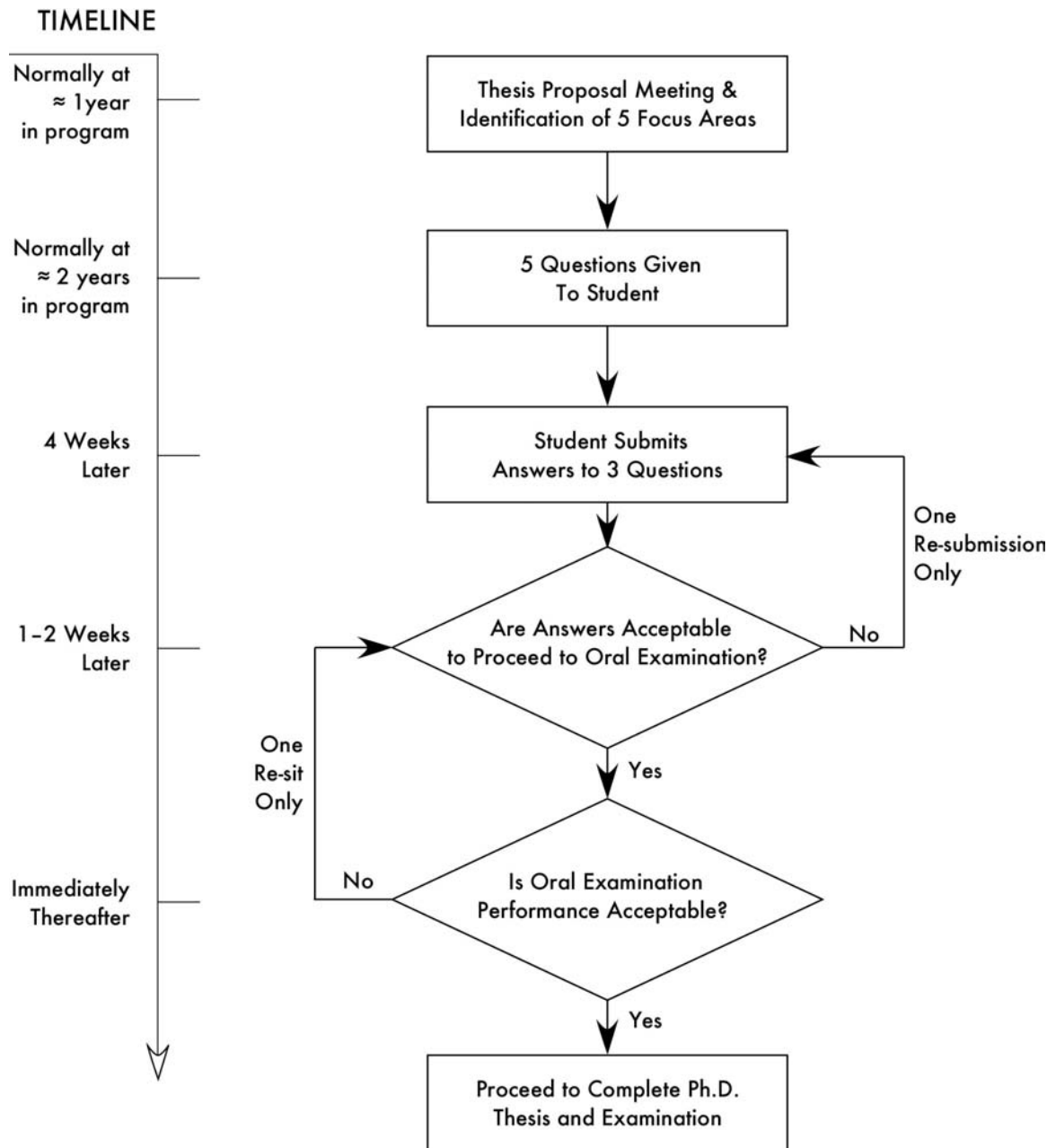


FIGURE 1: PROCEDURAL FLOWCHART AND TIMELINE FOR SUCCESSFUL PH.D. COMPREHENSIVE EXAMINATION IN BIOMEDICAL ENGINEERING

D. Membership of the Examination Committee

The Comprehensive Examination committee will consist of the candidate's Supervisory Committee, plus at least one other faculty member who is a member of the Faculty of Graduate Studies and who holds an appointment in SBME. The Comprehensive Examination committee should be formed at least one year in advance of the proposed Comprehensive exam: normally at the time of the defense of the thesis proposal.

E. Guidelines for Question Development

- (i) At least 2 months in advance of the scheduled exam, members of the Comprehensive Examination Committee with specific expertise in one or more of the core areas specified for study (in section C. above) should be identified and asked to draft one or more questions specific to their area. They should be instructed to pose questions that require the candidate to demonstrate a thorough understanding of the topic, and abilities to analyze, synthesize, and interpret the literature.
- (ii) Questions should be reviewed by all members of the Comprehensive Examination Committee to ensure that the scope of the exam addresses the topics identified.
- (iii) The questions should be reviewed by the SBME Graduate Coordinator at least two weeks in advance of the scheduled exam.
- (iv) Members of the Comprehensive Examination committee may provide key references related to their question(s) at any time prior to the exam if this is deemed appropriate. Where possible and as is deemed appropriate, they should also provide (on request from the candidate) guidance on interpretation and intention of the question(s).

F. Procedures for Written and Oral Components of the Examination

It is expected that the candidate will be familiar with the literature on the topics selected for examination prior to the exam: for instance in preparing and defending the thesis proposal and through normal study of the scientific/engineering literature. It is also expected that the candidate will have an understanding of the general thesis topic area. Therefore the examination will focus on the ability of the candidate to summarize this knowledge, critically analyze the literature, synthesize that information, and ***directly answer the questions posed.*** The candidate should anticipate that he/she will be required to devote their academic time exclusively to the examination during the 4-week examination period in order to provide quality written documents and then successfully defend those documents and his/her knowledge at the oral examination.

Prior to the start of the examination, the candidate will choose both the date of receipt of the questions and the date of the prospective oral exam—first obtaining agreement for the examination timetable from all examiners. The oral component should normally occur 5-6 weeks after commencement of the examination. Thus, the committee will normally have approximately 1–2 weeks to review the written documents and consider their acceptability as defined in Section G below.

At the beginning of the examination, the candidate will be presented by the Thesis Supervisor with the 5 questions approved by the Comprehensive Examination Committee and the Graduate Coordinator. **The candidate will then choose three (3 only) of these questions** and will answer them in three corresponding original, scholarly documents of 15-20 1.5-line-spaced pages in length (excluding figures, tables, and references). Each document will have the format of a scientific journal review paper and the candidate will have 4 weeks to complete all three documents before submitting them to the SBME Graduate Coordinator and thereby to the Comprehensive Examination Committee for review.

If and only if all three documents are judged by the Comprehensive Examination Committee as meeting (in its view) the standards for the examination, the candidate will be invited to defend the documents and his/her background knowledge of the research thesis area (as might be reviewed in the Introduction to the thesis) in a 2-3 hour oral examination similar in structure and conduct to the Ph.D. Oral Examination as described by the Faculty of Graduate Studies. This oral component of the examination will occur on the previously agreed upon date. This examination will normally be chaired by either the Graduate Coordinator or one of the committee members as chosen by consensus.

Successful examination will be based on consideration of both the written documents and the oral defense.

G. Evaluation of the Written Documents and Oral Examination

Written Document

1. *Did the candidate answer the questions posed?*
2. *Did the documents satisfy the expected level of academic performance as described in the second paragraph of Section A above.*
3. *Was the document written at such grammatical and scientific levels as would be expected in writing a successful Ph.D. thesis?*

In adjudicating the documents, the Comprehensive Examination Committee will seek consensus of opinion in answering questions 1–3 above **for each document submitted**. In the case where consensus is not achieved, a majority vote will rule. If there is an even number of committee members, a majority vote amongst the members—excluding the Thesis Supervisor—will rule.

The candidate will be given **at most one opportunity to revise those documents** submitted that are judged to not meet the standards of the examination. The time frame for the revisions will be agreed between the candidate and the Comprehensive Examination committee, and approved by the Graduate Coordinator, with the understanding that the revision process should not unduly inhibit the continuation of the candidate's experimental/theoretical work toward his/her thesis. As is deemed appropriate, the Committee members should provide detailed guidance to the candidate regarding improvement of the documents toward successful adjudication.

Successful written examination will be achieved by approval of *all three* documents submitted. Failure to achieve this approval in the maximum two rounds of submission will be considered grounds for the candidate's withdrawal from the Ph.D. program in Biomedical Engineering.

Oral Examination

In adjudicating the oral examination, the Comprehensive Examination Committee will seek consensus of opinion in answering questions 1–3 above *for each document submitted*. In the case where consensus is not achieved, a majority vote will rule. If there is an even number of committee members, a majority vote amongst the members—excluding the Thesis Supervisor—will rule.

1. *Did the candidate provide convincing answers to the questions posed during the oral examination?*
2. *Did the answers to the questions posed during the examination satisfy the expected level of academic performance as described in the second paragraph of Section A above.*
3. *Was the candidate able to support his/her answers with evidence from the literature?*
4. *Was the candidate able to engage in scientific dialogue appropriate to function in scientific meetings, presentations, etc.?*

The scope of the oral examination includes: (i) the 3 written documents submitted by the candidate in response to the posed questions, (ii) the 5 broad areas previously identified per Section C (above) for intensive study, and (iii) knowledge essential for successful completion of the Ph.D. thesis of the candidate, as referred to in Section A (i) evidence of substantial understanding of the thesis subject area.

The candidate will be given ***at most one opportunity to re-sit the examination*** and thereby meeting the expected standards as laid out in the second paragraph of Section A above. The time frame for the interval between oral examinations will be agreed between the candidate and the Comprehensive Examination committee, and approved by the Graduate Coordinator, with the understanding that the re-examination process should not unduly inhibit the continuation of the candidate's experimental/ theoretical work toward his/her thesis. As is deemed appropriate, the Committee members should provide detailed guidance to the candidate regarding improvement of the oral examination performance toward successful adjudication.

Failure to achieve approval of the oral examination performance in the maximum two rounds will be considered grounds for the candidate's withdrawal from the Ph.D. program in Biomedical Engineering.

H. Post-examination Remediation

In keeping with the pedagogical objectives of the Comprehensive Examination, the Committee may follow the examination with *recommendation* of remedial work for the candidate, the objective being to optimize the likelihood of success in writing the Ph.D.

thesis and in its oral defense. Such remedial work may consist of: (i) directed study of certain areas of the scientific/ engineering literature to supplement perceived areas of weakness; (ii) presentation of specified ideas/literature to a Supervisory Committee meeting; (iii) additional coursework; or (iv) other work as is deemed appropriate. These recommendations will be made with the understanding that the remedial process should not unduly inhibit the continuation of the candidate's experimental/ theoretical work toward his/her thesis. The remedial work will be carried out under the guidance of the Thesis Supervisor and the Supervisory Committee.

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Drafted by:

Janie Astephen (Ph.D. student representative), Paul Gratzner, Cheryl Kozey (Chair), Mike Lee, and Geoff Maksym