

**JOINT DOCTORAL PROGRAM IN
ENGINEERING AND COMPUTATIONAL
MATHEMATICS**

**Conducted by
California State University, Long Beach, and
Claremont Graduate University**



**INSTITUTE OF
MATHEMATICAL SCIENCES**
 **Claremont Graduate University**

STUDENT HANDBOOK

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Joint Doctoral Program in Engineering and Computational Mathematics

Introduction

The doctoral program in Engineering and Computational Mathematics is a joint program between the College of Engineering (COE) at California State University, Long Beach (CSULB), and the Institute of Mathematical Sciences at Claremont Graduate University (CGU). This program was approved by the CSULB Senate in 1987 and granted its first doctoral degree in 1995.

The Joint Doctoral Program was created with two educational goals that continue to be pertinent today:

- Develop a doctoral program that seeks to judiciously combine the computational mathematics field with one or more branches of engineering at both the academic and research level.
- Draw upon the synergistic expertise of the research faculty at both institutions to offer an interdisciplinary degree that integrates advanced techniques of mathematical analysis with advanced engineering coursework and research.

The program's key objective is to facilitate an individually designed program for each student in an interdisciplinary setting for advanced study and research. The College of Engineering at CSULB has the primary responsibility for the engineering portion of the program; the Institute of Mathematical Sciences at CGU has the primary responsibility for the computational mathematics portion. The program of study for each Ph.D. candidate is carefully integrated to ensure the interdisciplinary nature of each student's research.

Degree Designation

In accordance with an agreement between CGU and CSULB, the degree is designated the ***Doctorate of Philosophy in Engineering and Computational Mathematics*** and is granted at Claremont Graduate University in the name of the two universities. The diploma indicates the dual nature of the degree and specifies that it is granted only when requirements have been satisfied in both subject areas as specified by the collaborating institutions.

Program Supervision

Overall program supervision is the responsibility of the **Program Committee**, consisting of the directors of the Joint Doctoral Program (JDP) from each institution, the Dean of Mathematics at CGU, and the Dean of Engineering at CSULB.

Admission Requirements

Students must be admitted to both institutions jointly. Admission will be granted to a limited number of qualified students; therefore, application should be made as early as possible. Applications from underrepresented minorities are encouraged. Completed applications must be received by **April 15 for the fall semester** or **October 1 for the**

spring semester, although late applications are allowed at the discretion of the Program Committee. The Program Committee is responsible for making admission decisions consistent with campus regulations (see Application Procedure in this booklet). To be admitted to the Joint Doctoral Program, an applicant must have received a bachelor's or master's degree in science, engineering, or mathematics from an accredited institution. Moreover, he or she must have attained scholastic records and present confidential recommendations, which indicate that he or she is well qualified to pursue, with distinction, advanced study and research. Be advised that admission may be refused solely on the basis of limited facilities in the option desired.

GRE Requirement

The analytical, verbal, and quantitative portion of the Graduate Record Examination (GRE) is required before admission. GRE subject examinations (mathematics and engineering) are not required. Applicants whose first or native language is **not** English are required to have a **current** minimum score of 80 ibt on the *Test of English as a Foreign Language* (TOEFL); however, this requirement is waived for students with a bachelor's or master's degree from an accredited U. S. university.

Registration and Enrollment

It is important that students register and enroll in classes each semester at either CGU or CSULB. Failure to enroll at any given semester will be considered leave without permission (discontinued enrollment) and the student will be dropped from the program.

Program Planning and Supervision

At CSULB, an initial engineering advisor is assigned to the student at the time of admission. At CGU, the student needs to arrange with the program director, within the first semester of study, for a mathematics advisor. The student's program of study is arranged individually in collaboration with their advisors; the two advisors confer periodically regarding the student's progress. The Program Committee monitors the student's overall performance.

Course Work and Examinations

A minimum 72 units of course work, independent study, and research (including transfer credit) must be completed. Transfer credit of up to 24 units of related courses at the master's level is permissible on approval of the Program Committee; this course work must have been completed with at least a grade of B or above, at an accredited institution, and must be directly related to the joint program and the student's goals. Of the 72 units, a minimum of 24 units must be completed in the graduate engineering program at CSULB and a minimum of 24 units in the graduate mathematics program at CGU. Both sets of 24 units must conform to the area requirements of the relevant institution and **must be approved by the Program Committee**. All degree requirements must be completed within seven years (or six with the transfer of 24 units according to CGU regulations) from the time a student begins doctoral study.

Every doctoral student must maintain a minimum cumulative grade-point average (GPA) of 3.0. Students are put on academic probation if they fail to maintain a cumulative or term GPA of at least 3.0 in all units attempted subsequent to admission to the degree program. After two consecutive semesters on probation, students are subject to disqualification if they fail to earn sufficient grade-points to be removed from the probationary status.

CSULB Minimum Course Requirement

The following three courses (12 units) are required at CSULB to meet the 24-unit course requirement:

- ENGR 795: Advanced Directed Studies (4 units)
- ENGR 796: Doctoral Seminar (2 units required)
- ENGR 798: Doctoral Dissertation (6 units allowed)

The remaining 12 units of course work for students who have received transfer credit, may include ENGR 790, Selected Topics in Engineering and other advanced graduate courses relevant to the student's program of study.

Minimum Student Load per Semester

It is **highly recommended** that doctoral students enroll in at least 9.0 units per semester in order to demonstrate progress towards the degree. The CSULB director of the program, in consultation with the doctoral advisor, **may require** that a student take at least 9.0 units per semester if the student is not showing adequate progress.

These courses may include the following:

- ENGR 797A: Preparation for Ph.D. Preliminary Examinations
- ENGR 797B: Preparation for Ph.D. Qualifying Examination
- ENGR 797C: Research for Ph.D. Dissertation

Students may take from 4.0 to 12.0 units of ENGR 797A, ENGR 797B or ENGR 797C each semester, though these courses may not be used to fulfill the 72-unit course work. These courses are offered on Credit/No Credit bases and are designed to formally recognize the students' efforts towards the program.

Residency Requirements

Doctoral students must complete their program within a period of seven years (or six with the transfer of 24 units) according to CGU regulations (see below). During this time, a minimum of 72 units of course work, independent study, and research (including transfer credit) must be completed. Normally no more than 16 units per semester may be credited toward the degree. No more than 12 units per summer session may be credited toward the degree. The transfer of credit form is available on the CGU website. The Program Committee will consider petitions for extensions and/or exemptions. All degree requirements must be completed within seven years from the time a student

begins graduate study. Work for which transfer credit is granted will be counted as part of the seven years, e.g., if transfer credit of 24 units (one year) is granted, the time limit will be six years.

The residency requirements for the Ph.D. may be met either by two semesters of full-time study in a 24-month period or by the completion of 48 units of course work within a 48-month period (including work in the summer session). There are special provisions for students transferring units as described below.

Students who receive transfer credit for 12 units or less may meet the residency requirement either by completing two full-time semesters of course work within a 24-month period or by completing 36 units within a 48-month period. Those receiving transfer credit for 13 to 24 units may meet the residency requirement by completing 24 units within a 36-month period. The seven-year maximum time period for the Ph.D. degree is reduced by six months for 12 units or less of transfer credit and by 12 months for 13 to 24 units of transfer credit.

Plan of Study

After consultation with their advisors, students are **required** before the end of the second semester, to prepare and file with the Program Committee a Plan of Study (see page 14) for completing the course requirements for the degree. The purpose of the Plan of Study is to ensure that the student is aware of the requirements for the degree. The Plan of Study should indicate the areas of study that the student will be taking in preparation for the preliminary examinations. In consultation with the student's advisor and Program Committee, the Plan of Study may be altered at a subsequent time by petition.

If a student withdraws from the program after completing a substantial portion of the course work, a master's degree at either or both institutions is still possible by satisfaction of the appropriate requirements. Both CGU and CSULB require 30-36 semester units of course work that include culminating experiences for master's degrees.

Preliminary Examinations

The student is required to pass written preliminary examinations. These examinations consist of two examination areas: **one in engineering** and **one in mathematics**. These examinations are usually taken after completion of the relevant course work at each institution. These examinations are given two or three times a year at the discretion and under the control of the Program Committee. Should a student fail an examination, they may petition the Program Committee for one retake.

Before taking the first preliminary examination, the student **is required** to complete the Preliminary Examination Permission Form (available at the CSULB website, www.csulb.edu/colleges/coe, and see page 15). This form requires the student to specify the core areas of the Preliminary Examination; the student's intended dissertation advisor and the directors of the Joint Doctoral Program must sign the form. The purpose of this form is to certify that the student and dissertation advisor are in agreement on the set of examinations. If, in the course of time, this set of examinations and/or the advisor is amended, the form must be resubmitted. The preliminary

examinations are considered completed when the two examinations specified on the student's form have been successfully passed. You must be enrolled at CSULB in order to take the CSULB portion of the Preliminary Examinations.

With regard to the preliminary exams taken at CGU, the following conditions apply. If a student fails or forfeits his/her second attempt at a preliminary exam, he/she may submit a petition to the IMS Director, asking for permission to change the preliminary exam subject to a new one. The petition should provide a valid reason for allowing such a change.

Before deciding on the petition, the IMS Director will consult the student's academic and/or research advisors, the professor who administered the current preliminary exam and the corresponding Program Director(s). Students may be granted such a permission at most once while in the Ph.D. program.

Failure to successfully complete the preliminary examination requirement results in dismissal from the Ph.D. program. Therefore, dismissal from the Ph.D. program results from any one of the following:

- For either CGU or CSULB, the student fails preliminary examination in the same subject.
- For CGU, the student's first attempt at a preliminary examination results in failure, followed by a petition granted to take a preliminary exam in a different subject, followed by failure of that exam.

CGU Institute of Mathematical Sciences Course Requirement:

The following three core courses (12 units) are required at CGU to meet the 24-unit course requirement (letter grade B- or better should be received for each course):

1. Methods of Applied Mathematics (Math 294)
2. Continuous Modeling (Math 388)
3. Numerical Methods for Matrix Computations (Math 368)

The remaining 12 units of course work should be chosen after consulting their adviser, they may include no more than two terms of an industrial clinic or independent study.

CGU Institute of Mathematical Sciences Preliminary Examinations

The CGU IMS Preliminary examination is based on the three core classes stated above. It is recommended students take a preliminary exam soon after completing the required course(s). Preliminary exam is administered twice per year.

CSULB College of Engineering Preliminary Examinations

The College of Engineering requires a minimum of **three graduate courses** (graded B or above) as a basis for each Preliminary Examination. With the consent of their

dissertation advisor, students select **three topics from the list provided by the faculty advisor**. The list should be approved by the CSULB director of Joint Doctoral Program.

Research Tool

Students in the Joint Doctoral Program must demonstrate proficiency in problem-solving ability using computer programs. This demonstration may take different forms depending on the student's engineering sub-discipline, but must include evidence that the student has used an appropriate computer language and an algorithmic method to solve a problem from an engineering discipline.

Research and Dissertation

Upon completion of at least 48 units of course work (including transfer units), the preliminary examinations, and the research tool requirement, a student embarks on the research phase of the Joint Doctoral Program. In preparation for the research phase, the student is expected to spend at least a semester in advanced graduate courses, seminars, or directed reading courses where exposure to research material is emphasized. From these and other sources, the student gains the ability to understand the motivation for research in engineering and computational mathematics and learns to apply research techniques.

Doctoral Committee

During entry to the program and through the period of the main body of course work at CGU and CSULB, the Program Committee will monitor the student's progress. Upon successful completion of the preliminary examinations, the student petitions the Program Committee to constitute the Doctoral Committee. The student chooses this committee with advice from the faculty advisor and with approval of the Program Committee. The committee must include at least **two faculty members each from CGU and CSULB**; it must also provide breadth and depth in mathematics and engineering in the chosen faculty members. The Doctoral Committee supervises the student's progress through research preparation and dissertation writing; it also administers the qualifying and oral examinations for the degree. The chair of the Doctoral Committee is the dissertation supervisor.

Research Proposal and Qualifying Examination

With these advanced courses as background, and with the guidance of the Doctoral Committee, the student defines an area of proposed research and prepares a written Dissertation Proposal containing an outline of the research to be undertaken and references to relevant source materials. **The Dissertation Proposal is presented to the Doctoral Committee at least two weeks prior to the Qualifying Examination.** The appropriate form under "Doctoral Degree Forms" can be obtained from the CGU website www.cgu.edu (under Current Students, Registrar Information). The Qualifying Examination is an oral presentation to the Doctoral Committee describing the planned research. The student is expected to present evidence both as to the mathematical content and to the engineering application of the proposed research, supporting such evidence with references to previous research in both areas. The Doctoral Committee

judges the fitness and quality of the Dissertation Proposal from this presentation and from the written proposal. It subsequently communicates its recommendations to the Program Committee. Only upon a positive recommendation may the student embark on a dissertation. In the event of failure, the qualifying examination may be retaken once after petition to the Program Committee.

Advancement to Candidacy

After successful completion of the Qualifying Examination and certification that all other requirements are fulfilled, the student is advanced to candidacy. The appropriate form under “Doctoral Degree Forms” may be obtained from the CGU website. This must occur at least six months before the Final Oral Defense.

Dissertation and Final Oral Examination

Upon completion of the research, the student will prepare the dissertation in accordance with CGU regulations. A final draft of the dissertation will be presented to each member of the Doctoral Committee at least three weeks prior to the final oral examination. The appropriate form under “Doctoral Degree Forms,” along with an abstract of the dissertation, must be filed with CGU’s Office of Admission and Records three weeks before the exam. This deadline is very strict and no exceptions will be made. Please see the CGU website under “Academic Calendar” for the final defense scheduling dates. The oral defense will normally be held on the campus of the dissertation supervisor.

Research in the CGU/CSULB Joint Doctoral Program

Research in the CSULB College of Engineering

The College of Engineering offers courses in Engineering, Biomedical Engineering, Chemical Engineering, Civil Engineering, Computer Engineering and Computer Science, Electrical Engineering, and Mechanical and Aerospace Engineering. Doctoral students may select courses from one or more of these departments.

Presently, the college has more than eighty tenured/tenure track faculty members who teach and conduct research on a wide range of engineering and scientific areas as identified on each both departments and college web sites.:

The College of Engineering also supports several research centers, Institutes, and laboratories:¹

- Center for Energy and Environment Research and Services (CEERS)
- National Center for Transportation, Green Technologies, and Education (TransGet)
- Institute for Manufacturing and Automation Technologies (I-MAT)

¹ For more information on these centers visit <http://www.csulb.edu/college-of-engineering/research>

Research in the CGU Institute of Mathematics

The graduate curriculum in mathematics is supported by the six mathematical departments in the Claremont Colleges Consortium: Claremont Graduate University, Claremont McKenna College, Harvey Mudd College, Pitzer College, Pomona College, and Scripps College. There are currently about fifty full-time faculty members in the six departments. A broad spectrum of courses in the mathematical sciences is offered, including: algebra, topology, geometry, analysis, numerical analysis, ordinary and partial differential equations, probability, statistics, and many specialty areas (see <http://www.cgu.edu/pages/628.asp> for a full list of courses).

Applied mathematics is the focus of much of the faculty and graduate student research; these topics include applications in physics (semi-conductors), engineering (continuum mechanics), financial engineering, computational molecular biology and bioinformatics, satellite navigation, and computational fluid dynamics. All aspects (modeling, analysis, numerical) are treated.

The Institute of Mathematical Sciences at CGU also supports

- The CGU Mathematics Clinic
- The Claremont Research Institute of Applied Mathematical Sciences (CRIAMS)

Both of these centers organize research projects for industrial clients.

Contact Information

College of Engineering

- The director of the Joint Doctoral Program at CSULB is Dr. Hamid Rahai. His telephone number is (562) 985-8032; email address is hamid.rahai@csulb.edu.
- The CSULB Administrator is Kim Truesdelle. Her telephone number is (562) 985-8032; her email address is kim.truesdelle@csulb.edu.

Institute of Mathematical Sciences

- The director of the Joint Doctoral Program at CGU is Marina Chugunova. Her telephone number is (909) 607-9489; her email address is marina.chugunova@cgu.edu.
- The CGU Administrator is Charlotte Ballesteros. Her telephone number is (909) 621-8080; her email address is charlotte.ballesteros@cgu.edu.

Policies and Procedures

1. Throughout their entire program of study, unit-taking students must be registered at **either** CGU or CSULB. Students, who intend not to take course work at either institution, including those who have finished their required units, must take the necessary steps to maintain continuous enrollment. **This is achieved by registering for Math 499 (Doctoral Study) at Claremont Graduate University or by registering for Engineering 798 (Doctoral Dissertation) at California State University, Long Beach.** At least two semesters of registration for Math 499 at CGU must be maintained during the last year prior to graduation. In order for the degree to be conferred, a student must meet all regulations as stated in the CGU Bulletin under “Degree Regulations.”

Requests for **leave of absence** must be submitted to each registrar’s office and approved by both institutions according to the standards of each; upon approval of leave the student should advise the math office at CGU and the office of the Joint Doctoral Program at CSULB. Students should contact each registrar’s office for leave of absence policies. If the student fails to advise the registrar at CGU of his/her leave granted by CSULB, he/she will be dropped from the program (CGU has no official arrangement for leaves). Upon return, the student will be required to pay CGU a reinstatement fee in addition to regular semester tuition.

2. International students registered for units at CSULB must provide the CGU International Student Advisor, Ariel Carpenter, with proof of registration within two weeks of the beginning of the semester at CGU. Proof of full-time registration (8 units minimum) is required to maintain immigration status. (In the circumstance of completion of units, registration in Doctoral Study, CGU Math 499, is required.)
3. Students should arrange for advisors, one in math at CGU and one in engineering at CSULB, at the earliest opportunity. The program committee will help provide advisors.
4. After consultation with their advisors, students must submit a plan of study, including a petition for transfer of credits, if applicable, during their first year of study. The Plan of Study must be approved and transfer of units recommended to the Registrar by the program committee.

Procedures for Student Admission²

1. Students must complete online application forms at **both** CGU and CSULB. The application materials that include official transcripts, three letters of reference (preferably on the forms supplied in the CGU package), a personal statement and a resume, and test scores must be sent to both institutions. Current, official GRE scores are required. Scores may not be older than 5 years.

For CGU, you can apply here: <https://admissions.cgu.edu/apply/>

For CSULB, you can apply here: <https://www2.calstate.edu/apply>

2. The CGU director of the CSULB/CGU Joint Doctoral Program, Marina Chugunova, reviews completed files. In the event of a negative review, a rejection letter is issued by CGU. In the event of a positive review, the application, along with a copy of the completed file, is forwarded to the CSULB director of the CSULB/CGU Joint Doctoral Program, Dr. Hamid Rahai.
3. Results of the Long Beach review are transmitted back to CGU Math. Upon a positive review by CSULB, the application and fee are sent to the CSULB Admissions Office to be processed. A negative review initiates a rejection letter from CGU.
4. Upon admission to the program, CGU will generate two admission letters; one is mailed to the student and one is sent to CSULB. This letter includes a decision card and specifies a required \$300 tuition deposit that should be submitted to CGU if the student chooses to accept the offer of admission.
5. Students admitted to **provisional status** must provide the materials needed to complete their files before the end of their first semester of enrollment. Official scores for the GRE General Test are required of all students before admission to full graduate standing. The joint faculty program committee will review completed files for change of status.

(Revised 8/2019)

² Please note that only completed files are transmitted from CGU to CSULB. Information on the status of a file is available only from CGU's Office of Admission and Records. Their contact telephone number is (909) 607-0434; their e-mail is admiss@cgu.edu.