

**Applied Mathematics Graduate Program
Ph.D. AND/OR MS/MA DEGREE REQUIREMENTS**

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A. Introduction

- 1) **Aims and Scope:** Applied Mathematics Graduate Studies (AMGS) at UC Merced explores the applications of mathematics in the development of natural sciences, engineering and social sciences. The Applied Mathematics Graduate Group offers a multidisciplinary research and training program leading to Master of Science (M.S.) and Doctor of Philosophy (Ph.D.) degrees in applied mathematics. The course work provides a background in the fundamental tools of applied mathematics, including ordinary and partial differential equations, asymptotics and perturbation methods, numerical analysis and scientific computing. Research projects involve the **modeling of complex systems** across a broad range of fields including protein dynamics, biofluids, organismal biology, molecular dynamics, cold atoms, solar energy, astrophysics, integrated circuits, biomedical imaging, geophysics, wireless communications, energy resource management, finance, and image processing — just to name a few. The faculty members engage actively in **scientific computing** research, including developing, implementing and testing algorithms to solve partial differential equations, optimization problems, and simulate stochastic processes, for example. The newest strategic focus is on **data science**. Data science and engineering is a research field that has emerged with rapid advances in technology that allow for the gathering and storage of massive quantities of data. These massive data sets are beyond the capacity of most traditional methods for analysis. Several faculty members have established expertise in this field in the areas of genomic sciences, imaging sciences, data mining and mathematical finance, for example.

- 2) **Admissions Requirements:** Consideration for graduate group admission requires a bachelor's degree, three letters of recommendation, official transcripts, GRE scores, TOEFL or IELTS score (if applicable) and submission of the graduate online application with fee by the stated admission deadline. A minimum GPA of 3.0 is required. Admission decisions are made on a case-by case basis. Meeting some or all of these criteria does not guarantee admission, but merely eligibility. The decision to recommend admission to the Vice Provost and Dean of Graduate Education will be made by the Graduate Group Admissions Committee on the basis of available space and the competitiveness of applicants compared to the eligible pool.
 - a) **Prerequisites:** All incoming students are required to have a Bachelor's degree in applied mathematics or a related field. In particular, the undergraduate preparation should include courses in advanced calculus, linear algebra, differential equations, and complex variables.

 - b) **Deficiencies:** Coursework deficiencies should be made up by the end of the first academic year following initial enrollment by earning a letter grade of "B" or better.

- 3) **General Committees:**
 - a) The **Executive Committee (EC)** is elected by vote of the faculty in the group. The EC consists of three members, who will serve rotating terms of five years. (The original five members will serve terms of three, four, and five years.) The

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Group Chair will serve as an *ex officio* member of the EC. EC responsibilities include:

- i. Approve membership in the Applied Mathematics Graduate Group.
- ii. Prepare an annual slate of nominees that will be put before the membership for election to serve on the EC. Members can be re-elected and serve two consecutive five year terms but must sit out one election cycle before running for a third term.
- iii. In consultation with the group faculty, determine and implement policy for the good of the Group, establish and guide the educational requirements of the Group, and represent the interests of the Group to the University and other agencies.
- iv. Appoint members to five standing committees (Membership, Educational Policy, Admissions, Awards, and Preliminary Exams) at the beginning of the Fall semester. The EC may choose to not constitute a particular committee as a separate body, in which case the EC will assume the responsibilities of that committee. Committee formation and appointments will be reviewed on an annual basis.

The composition and duties of the five standing committees are as follows:

- b) Membership Committee.** This committee consists of two faculty members and is responsible for reviewing applications from faculty who wish to be part of the Group. In addition, the Membership Committee will review the membership of the Graduate Group Faculty every three years. The MC will recommend to the EC approval or denial of membership in the Graduate Group.
- c) Educational Policy Committee (EPC).** The EPC consists of three faculty members and one graduate student representative. This committee is responsible for establishing and guiding the educational programs of the Group. The EPC will be formed by the EC as needed and will periodically conduct reviews of the programs, including the five-year review. The EPC, in consultation with the group faculty, will determine changes in programmatic requirements of AMGP. In particular, the EPC will be responsible for review and changes in the program's curriculum, Program Learning Outcomes, program assessment, and substantive change review.
- d) Admissions and Recruitment Committee.** This committee consists of five faculty members. This committee is charged with the development of recruiting materials for the Group, reviewing applications for admissions, making recommendations for admissions to the Dean of Graduate Studies, exploring graduate student support mechanisms, and allocating intramural financial assistance.
- e) Awards Committee.** This committee consists of three faculty members. This committee is charged with reviewing applications for graduate student awards, selection of nominees for these awards, and writing the nomination materials.
- f) Preliminary Exams Committee.** This committee is responsible for writing, administering, and grading the preliminary exams at the beginning and end of

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the Spring semester. The committee consists of five faculty members: an organizer together with four faculty members, who each agree to write and grade one of the four preliminary exams. In case the organizer writes and grades one exam, then the committee will consist of four total faculty members.

B. Master's Degree Requirements

1) Degree Plan I- Thesis: This plan requires a minimum of 36 semester units in approved courses, at least 28 of which must be earned in 200- and/or 300-series graduate-level courses exclusive of credit given for thesis research and preparation. A preliminary examination is also required.

a) Program Learning Outcomes (PLOs): Upon graduating, students completing the **M.S. degree, Plan I**, are expected to be able to

- i) Solve advanced mathematical problems using analytical methods.
- ii) Solve advanced mathematical problems using computational methods.
- iii) Give clear and organized written and verbal explanations of mathematical ideas to a variety of audiences including teaching undergraduate students.
- iv) Model real-world problems mathematically and analyze those models using their mastery of the core concepts.
- v) Recognize ethical and responsible conduct and learn how to apply them to research.
- vi) Make an original contribution to the knowledge in a chosen research subfield of Applied Mathematics.

b) Course Requirements - Core and Electives (total 28 units)

i) Core Courses (total 24 units)

Course Number	Course Name	Units
Math 221	Partial Differential Equations I	4
Math 222	Partial Differential Equations II	4
Math 231	Numerical Solution of Diff. Equations I	4
Math 232	Numerical Solution of Diff. Equations II	4
Math 223	Asymptotics and Perturbation Methods	4
Math 201	Teaching and Learning in the Sciences	1 (S/U)
Math 399	University Teaching	1 (S/U)
Math 291	Applied Mathematics Seminar	1 (S/U)
Math 291	Applied Mathematics Seminar	1 (S/U)

ii) Elective Courses (4 units)

Course Number	Course Name	Units
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Special Topics	See item c), part ii) below	4
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iii) Summary: 24 units of core coursework and 4 units of elective coursework are required for a total of 28 units of coursework. Full-time students must enroll for 12 units per semester including research, academic and seminar units. Except for the 1-unit courses specifically indicated above, courses that fulfill any of the course requirements may not be taken S/U. All letter-graded core and elective courses must be completed with a minimum grade of "B." Once course requirements are completed, students can generally take additional classes as needed, although the 12 units per semester are generally fulfilled with a research class, Math 295. Per UC regulations, students cannot enroll in more than 12 units of graduate-level courses (200- or 300-level) in one semester. Electives are chosen with the approval of the graduate advisor.

c) Special Requirements:

i) Preliminary exam requirement. Preliminary examinations are offered at the beginning and end of the Spring semester each year. These are four closed-book written examinations in (i) differential equations, (ii) advanced calculus, (iii) complex variables and (iv) linear algebra. The examinations are given at the advanced undergraduate / beginning graduate level. For each of the four exams, students receive a score of 1 (Not Pass), 2 (M.S. Pass) or 3 (Ph.D. Pass), as determined by the Preliminary Exams Committee.

All students in the graduate program are required to take the preliminary exams at the beginning of the Spring semester of their first year of study. The dates of these exams will be determined during the preceding Fall semester. M.S. Plan I students must obtain a score of at least 2 on all four exams. A student may retake any or all of the four exams at the end of the same Spring semester. If the student does not obtain a score of at least 2 on all four exams after two attempts, he or she will be disqualified from further study in the graduate program.

ii) Special Topics requirement. To satisfy the requirement of a Special Topics course—item b), part ii) above—a student may take Math 292 (Special Topics in Applied Mathematics). Recognizing the interdisciplinary nature of research in applied mathematics, students may, with the approval of their advisor, satisfy the Special Topics requirement by either taking a graduate-level (200- or 300-level) course from another discipline, or by taking a letter-graded Math 298/299 course. In any case, the Special Topics course must be completed with a minimum grade of "B."

iii) Teaching requirement. M.S. Plan I students must serve as a half-time Teaching Assistant (TA) for at least one semester (or equivalent).

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- d) **Advancement to Candidacy:** Before advancing to candidacy for the Master's degree, a student must have satisfied all coursework requirements (described above under "b) Course Requirements" and all special requirements (described above under "c) Special Requirements." Students must have maintained a minimum GPA of 3.0 in all coursework undertaken. Normally, students advance by the end of the fourth semester. The student must file the appropriate paperwork (Application for Advancement to Candidacy for the Master's Degree and Conflict of Interest Form).
- e) **Thesis Requirements:**
- i) *Thesis committee meetings.* The candidate and advisor should meet at least once a year with the other members of the thesis committee to discuss progress and any changes in research objectives.

Written thesis. Research for the Master's thesis is to be carried out under the supervision of a faculty member of the program and must represent an original contribution to knowledge in the field. The work must be the student's and it must be original. The student is encouraged to discuss with members of the thesis committee both the substance and the preparation of the thesis well in advance of the planned defense date. The thesis research must be conducted while the student is enrolled in the program. The thesis is submitted to the thesis committee at least one month before the scheduled defense. If any member of the thesis committee determines that there are significant errors or shortcomings in the thesis or that the scope or nature of the work is not adequate for a M.S. degree, the student must address these shortcomings. All committee members must approve the thesis in its entirety and sign the title page before the thesis is submitted electronically to the Graduate Division for final approval. Should the committee determine that the thesis is unacceptable, even with substantial revisions; the program may recommend the student for disqualification from the program to the Vice Provost and Dean of Graduate Education.

The thesis must be submitted by the deadline in the semester in which the degree is to be conferred. Those students who complete requirements and submit thesis after the end of the semester and prior to the start of the subsequent semester will earn a degree for the following semester. Instructions on preparation of the thesis are available in the UCM Thesis and Dissertational Manual and a schedule of dates for filing the thesis in final form are published on the Graduate Division website in the calendar and deadlines section.

- ii) *Thesis defense and final examination.* All students in M.S. Plan I are required to defend the thesis prior to obtaining the M.S. degree. The student must schedule a tentative date for the thesis defense in consultation with the thesis committee. The oral component of the defense consists of two parts.

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The first part, open to the public, is a presentation of the material in the written thesis. The second part is an oral examination that serves to ascertain the breadth of a student's comprehension of fundamental facts and principles from his or her graduate course work. This part is closed to the public – only the student and the thesis committee are present.

At the conclusion of the examination, the thesis committee shall vote on whether both the written thesis proposal and the student's performance on the exam are of satisfactory quality to earn a University of California M.S. degree. A simple majority is required for a pass. Members of the committee may vote to make passing the exam contingent on corrections and/or revisions to the thesis. In such a case, the thesis committee will select one member, normally the graduate Research Advisor, who will be responsible for approving the final version of the thesis that is filed with the Graduate Division. Each committee member must complete the Thesis Evaluation Rubric form after the exam – see Appendix B.3. The student must submit the thesis in PDF form to the Graduate Chair no later than one month after the final examination date. The student must also file the final written thesis with the Graduate Division.

2) Degree Plan II- Capstone: This plan requires a minimum of 36 semester units in approved courses, at least 32 of which must be earned in 200- and/or 300-series graduate-level courses exclusive of credit given for thesis research and preparation. A preliminary examination is also required.

a) Program Learning Outcomes (PLOs): Upon graduating, students completing the **M.S. degree, Plan II**, are expected to be able to

- i) Solve advanced mathematical problems using analytical methods.
- ii) Solve advanced mathematical problems using computational methods.
- iii) Give clear and organized written and verbal explanations of mathematical ideas to a variety of audiences including teaching undergraduate students.
- iv) Model real-world problems mathematically and analyze those models using their mastery of the core concepts.
- v) Recognize ethical and responsible conduct and learn how to apply them to research.
- vi) Present a capstone project that extends well beyond the undergraduate curriculum.

b) Course Requirements - Core and Electives (total 32 units)

i) Core Courses (total 24 units)

Course Number	Course Name	Units
Math 221	Partial Differential Equations I	4
Math 222	Partial Differential Equations II	4

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Math 231	Numerical Solution of Diff. Equations I	4
Math 232	Numerical Solution of Diff. Equations II	4
Math 223	Asymptotics and Perturbation Methods	4
Math 201	Teaching and Learning in the Sciences	1 (S/U)
Math 399	University Teaching	1 (S/U)
Math 291	Applied Mathematics Seminar	1 (S/U)
Math 291	Applied Mathematics Seminar	1 (S/U)

ii) Elective Courses (8 units)

Course Number	Course Name	Units
Special Topics	See item c), part ii) below	4
Special Topics	See item c), part ii) below	4

iii) **Summary:** 24 units of core coursework and 8 units of elective coursework are required for a total of 32 units of coursework. Full-time students must enroll for 12 units per semester including research, academic and seminar units. Except for the 1-unit courses specifically indicated above, courses that fulfill any of the course requirements may not be taken S/U. All letter-graded core and elective courses must be completed with a minimum grade of "B." Once course requirements are completed, students can generally take additional classes as needed, although the 12 units per semester are generally fulfilled with a research class, Math 295. Per UC regulations, students cannot enroll in more than 12 units of graduate-level courses (200- or 300-level) in one semester. Electives are chosen with the approval of the graduate advisor.

c) Special Requirements:

i) *Preliminary exam requirement.* Preliminary examinations are offered at the beginning and end of the Spring semester each year. These are four closed-book written examinations in (i) differential equations, (ii) advanced calculus, (iii) complex variables and (iv) linear algebra. The examinations are given at the advanced undergraduate / beginning graduate level. For each of the four exams, students receive a score of 1 (Not Pass), 2 (M.S. Pass) or 3 (Ph.D. Pass), as determined by the Preliminary Exams Committee.

All students in the graduate program are required to take the preliminary exams at the beginning of the Spring semester of their first year of study. The dates of these exams will be determined during the preceding Fall semester. M.S. Plan II students must obtain a score of at least 2 on all four exams. A student may retake any or all of the four exams at the end of the

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same Spring semester. If the student does not obtain a score of at least 2 on all four exams after two attempts, he or she will be disqualified from further study in the graduate program.

- ii) *Special Topics requirement.* To satisfy the requirement of two Special Topics courses—item b), part ii) above—a student may take Math 292 (Special Topics in Applied Mathematics). Math 292 may be repeated for credit, as long as the subject matter of past and present Math 292 courses does not overlap significantly. Recognizing the interdisciplinary nature of research in applied mathematics, students may, with the approval of their advisor, satisfy the Special Topics requirement by either taking graduate-level (200- or 300-level) courses from another discipline, or by taking letter-graded Math 298/299 courses. In any case, the Special Topics courses must be completed with a minimum grade of “B” in each course.
- iii) *Teaching requirement.* M.S. Plan II students must serve as a half-time Teaching Assistant (TA) for at least one semester (or equivalent).

- d) **Advancement to Candidacy:** Before advancing to candidacy for the Master’s degree, a student must have satisfied all coursework requirements (described above under “b) Course Requirements” and all special requirements (described above under “c) Special Requirements.” Students must have maintained a minimum GPA of 3.0 in all coursework undertaken. Normally, students advance by the end of the fourth semester. The student must file the appropriate paperwork (Application for Advancement to Candidacy for the Master’s Degree and Conflict of Interest Form).
- e) **Capstone:** The M.S. Capstone Project should be a written document presenting research accomplished under the supervision of the faculty advisor. The capstone project should present material that extends well beyond the undergraduate curriculum. Both the faculty advisor and at least one additional reviewer must approve the capstone project. Both reviewers must be members of the applied mathematics graduate group. Each reviewer must complete the Capstone Evaluation Rubric (see Appendix B.2). The student must submit the final Capstone Project in PDF form to the chair of the graduate program no later than one month after the project has been approved. The student must also file the final Capstone Project with the Graduate Division.

- 3) **Advising Structure and Mentoring:** Initial Advisors will advise students during their first year of study. The Initial Advisor will be assigned based on an incoming student’s application to AMGP and the availability of faculty resources. The Initial Advisor will be responsible for the initial advising of graduate students. This includes advising students on (i) completion of first-year coursework requirements and preliminary exams, (ii) identifying a Research Advisor with matching interests, (iii) adjusting to the intellectual depth and rigor of graduate studies, and (iv) balancing graduate education with TA duties. The Initial Advisors should meet with their

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advised students at least three times during the Fall semester and three times during the Spring semester to monitor progress. Students are encouraged to enroll in a 1-unit Math 298 (Directed Group Study) course with their Initial Graduate Advisor in their first semester of the program. The Math 298 course may cover a range of topics intended to smooth the transition from undergraduate- to graduate-level studies in applied mathematics.

Beginning with their second year of graduate studies, all M.S. students must have a faculty Research Advisor. Student in the M.S. Plan I (Thesis) must establish a thesis committee in consultation with the Research Advisor by the end of their second year of studies and prior to defending the M.S. thesis, whichever comes first.

The M.S. Plan I thesis committee consists of three UC Senate faculty, one of whom must be the student's faculty Research Advisor. The Chair of the thesis committee shall always be a member of the Applied Mathematics Graduate Group.

The student, in consultation with his/her graduate Research Advisor, the Graduate Group faculty, and the Graduate Group Chair, nominate three faculty to serve on the thesis committee. These nominations are submitted to the Graduate Division for formal appointment in accordance with Graduate Council policy.

Once the M.S. Plan I thesis committee has been established, students should meet with the thesis committee at least once a year to report progress towards degree. See Appendix B.1 for a report template. In addition, students are encouraged to meet with their committee members and solicit their feedback well in advance of submitting an official thesis or research proposal.

All members of the committee must be in attendance for the M.S. Plan I thesis defense. If a thesis committee member's absence from campus for an extended period of time makes scheduling of examinations unreasonably difficult, the student may request that the committee be reconstituted. Reconstitution of the committee may also be justified by a substantial change in the student's dissertation topic or may be required by the departure of a committee member from the university. When membership changes must be made, the graduate advisor in consultation with the student should recommend a new committee member, giving the reason for the change. The change must be approved by the Graduate Group Chair in consultation with the Executive Committee.

For all matters involving advising and mentoring of graduate students that are not mentioned explicitly in this document, please refer to the [UCM Mentoring Guidelines](#).

4) Master's Degree Committees:

- a) **Thesis Committee:** The M.S. Plan I thesis committee consists of three UC Senate faculty, one of whom must be the student's faculty Research Advisor. The Chair of the thesis committee shall always be a member of the Applied Mathematics Graduate Group.

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The student, in consultation with his/her graduate Research Advisor, the Graduate Group faculty, and the Graduate Group Chair, nominate three faculty to serve on the thesis committee. These nominations are submitted to the Graduate Division for formal appointment in accordance with Graduate Council policy.

5) Normative Time to Degree: For both the M.S. Plan I and M.S. Plan II degrees, the normative time to degree is two years, i.e., four semesters of full-time enrollment.

6) Typical Timeline and Sequence of Events:

<i>Year One</i>	<i>Fall</i>	<i>Spring</i>
	<i>Math 221: PDE I</i>	<i>Math 222: PDE II</i>
	<i>Math 231: Num. Sol. Diff. Eqns. I</i>	<i>Math 232: Num. Sol. Diff. Eqns. II</i>
	<i>Math 291: Applied Mathematics Seminar</i>	<i>Math 223: Asymptotics and Perturbation Methods</i>
	<i>Math 201: Teaching and Learning in the Sciences</i>	<i>January: First attempt at passing four preliminary exams with min. score of 2.</i>
	<i>Math 399: University Teaching</i>	<i>May: Second and final attempt at passing four preliminary exams.</i>
	<i>Math 298: Directed Group Study (with Initial Advisor)</i>	<i>Find faculty Research Advisor (both M.S. Plan I and Plan II) and form thesis committee (M.S. Plan I only) before the beginning of the Fall semester of Year 2.</i>
<i>Year Two</i>	<i>Fall</i>	<i>Spring</i>
	<i>Math 292: Special Topics in Applied Mathematics (both M.S. Plan I and Plan II)</i>	<i>Math 292: Special Topics in Applied Mathematics (M.S. Plan II only)</i>
	<i>Math 295: Graduate Research</i>	<i>Math 295: Graduate Research</i>
	<i>Students should begin their research in the summer immediately following the Spring semester of their first year.</i>	<i>Complete thesis/capstone project by the end of the Spring semester, in accordance with rules given above.</i>

Note: In case a student finds it necessary to remedy deficiencies in mathematical background/preparation, it is possible to enroll in undergraduate-level courses (e.g., complex variables, partial differential equations, and/or numerical analysis) in the first year of study. In this case, with the exception of the preliminary exams, the timetable given above may be shifted back by one year, i.e., the courses/research listed above under "Year One" and "Year Two" will take place under "Year Two" and "Year Three." However, regardless of whether deficiencies are being remedied, all M.S. students must pass the preliminary exams by the end of their first year of study.

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- 7) **Sources of Funding:** Graduate students in Applied Mathematics are normally offered financial support through appointment either as a Teaching Assistant (TA), Teaching Fellow (TF), and/or Graduate Student Researcher (GSR).

Students in their first semester of residence usually serve as TAs for appropriate courses in the schools of Natural Sciences or Engineering. After the first semester, support may be offered through either funding as a TA or a GSR in the graduate research adviser's group. Graduate students with external fellowships are still required to satisfy the teaching requirement and will be paid by the school for teaching. While every effort will be made to provide employment as a TA, Teaching Fellow, or GSR for all graduate students in residence, admission to graduate studies carries no guarantee of financial support beyond that specified in the initial letter of commitment of financial support (if any). During the academic year, appointments are limited to 49.9% time. During academic breaks and summer months, students may be appointed at 100% time when research funds to support additional GSR support are available. Finally, to receive financial support from the university, students must be in good academic standing.

C. Doctoral Degree Requirements

The Doctor of Philosophy degree is granted to students who demonstrate a thorough knowledge of a broad field of learning and have given evidence of distinguished accomplishment in that field. The degree also signifies that the recipient has critical ability and powers of imaginative synthesis as demonstrated by a Ph.D. dissertation containing an original contribution to knowledge in his or her chosen field of study.

- 1) **Program Learning Outcomes (PLOs):** Upon graduating, students completing the **Ph.D. degree** are expected to be able to
- Formulate well-posed mathematical problems and provide analytical insight for solving them.
 - Design, implement, and validate potentially novel computational methods for solving mathematical problems.
 - Give clear and organized written and verbal explanations of mathematical ideas to a variety of audiences including teaching undergraduate students.
 - Model real-world problems mathematically and analyze those models using their mastery of the core concepts.
 - Recognize ethical and responsible conduct and learn how to apply them to research.
 - Make an original and significant contribution to the knowledge in a chosen research subfield of Applied Mathematics.

2) **Course Requirements - Core and Electives (total 40 units)**

a) **Core Courses (total 32 units)**

Course Number	Course Name	Units
Math 221	Partial Differential Equations I	4

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Math 222	Partial Differential Equations II	4
Math 231	Numerical Solution of Diff. Equations I	4
Math 232	Numerical Solution of Diff. Equations II	4
Math 233	Scientific Computing	4
Math 223	Asymptotics and Perturbation Methods	4
Math 224	Advanced Methods of Applied Mathematics	4
Math 201	Teaching and Learning in the Sciences	1 (S/U)
Math 399	University Teaching	1 (S/U)
Math 291	Applied Mathematics Seminar	1 (S/U)
Math 291	Applied Mathematics Seminar	1 (S/U)

b) Elective Courses (total 8 units)

Indicate course number, course name, and number of units

Course Number	Course Name	Units
Special Topics	See item 3), part b) below	4
Special Topics	See item 3), part b) below	4

- c) Summary:** 32 units of core coursework and 8 units of elective coursework are required for a total of 40 units of coursework. Full-time students must enroll for 12 units per semester including research, academic and seminar units. Except for the 1-unit courses specifically indicated above, courses that fulfill any of the course requirements may not be taken S/U. All letter-graded core and elective courses must be completed with a minimum grade of "B" and a grade point average (GPA) of at least 3.25. Once course requirements are completed, students can generally take additional classes as needed, although the 12 units per semester are generally fulfilled with a research class, Math 295. Per UC regulations, students cannot enroll in more than 12 units of graduate-level courses (200- or 300-level) in one semester. Electives are chosen with the approval of the graduate advisor.

3) Special Requirements:

- a) Preliminary Exam Requirement.** Preliminary examinations are offered at the beginning and end of the Spring semester each year. These are four closed-book written examinations in (i) differential equations, (ii) advanced calculus, (iii) complex variables and (iv) linear algebra. The examinations are given at the advanced undergraduate / beginning graduate level. For each of the four exams, students receive a score of 1 (Not Pass), 2 (M.S. Pass) or 3 (Ph.D. Pass), as determined by the Preliminary Exams Committee.

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All students in the graduate program are required to take the preliminary exams at the beginning of the Spring semester of their first year of study. The dates of these exams will be determined during the preceding Fall semester. Ph.D. students must obtain a score of 3 on at least three of the four exams, and a score of at least 2 on the remaining exam. A student may retake any or all of the four exams at the end of the same Spring semester. If the student does not obtain a score of at least 2 on all four exams after two attempts, he or she will be disqualified from further study in the graduate program.

- b) **Special Topics Requirement.** To satisfy the requirement of two Special Topics courses—item 2), part b) above—a student may take Math 292 (Special Topics in Applied Mathematics). Math 292 may be repeated for credit, as long as the subject matter of past and present Math 292 courses does not overlap significantly. Recognizing the interdisciplinary nature of research in applied mathematics, students may, with the approval of their advisor, satisfy at most one of the two Special Topics courses by either taking graduate-level (200- or 300-level) courses from another discipline, or by taking letter-graded Math 298/299 courses. In any case, the Special Topics courses must be completed with a minimum grade of “B” in each course.
 - c) **Teaching Requirement:** Ph.D. students must serve as a half-time Teaching Assistant (TA) for at least two semesters (or equivalent).
 - d) **Presentation Requirement:** All Ph.D. students are required to give at least one open technical oral presentation while in residence. This presentation needs to demonstrate original research. This presentation must be in a conference, workshop, or a departmental seminar series such as the Applied Mathematics Seminar. The open presentations given as part of the Ph.D. qualifying examination and dissertation defense may not be counted as one of the required seminars. The topic of the presentation may be the student’s own research or it may be any other topic that falls within the areas of study spanned by the group, broadly defined.
- 4) **Dissertation Plan:** In accordance with University of California policy, a minimum of four semesters in academic residence is required prior to awarding the Ph.D. Typically, a longer period of study, four to six years, is required for completion of all degree requirements. It is the responsibility of the Graduate Group to inform the student upon admission to the program of the expected degree time. All graduate students are considered resident graduates not candidates for a degree, unless admitted to candidacy after completion of all candidacy requirements and approval by the Graduate Division after formal application. A student advances to candidacy for the Ph.D. upon successfully demonstrating a high level of scholarship at the Ph.D. level, and upon completing all preparatory work and demonstrating readiness to proceed to the dissertation phase.

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- 5) **Advising Structure and Mentoring:** Initial Advisors will advise students during their first year of study. The Initial Advisor will be assigned based on an incoming student's application to AMGP and the availability of faculty resources. The Initial Advisor will be responsible for the initial advising of graduate students. This includes advising students on (i) completion of first-year coursework requirements and preliminary exams, (ii) identifying a Research Advisor with matching interests, (iii) adjusting to the intellectual depth and rigor of graduate studies, and (iv) balancing graduate education with TA duties. The Initial Advisors should meet with their advised students at least three times during the Fall semester and three times during the Spring semester to monitor progress. Students are encouraged to enroll in a 1-unit Math 298 (Directed Group Study) course with their Initial Graduate Advisor in their first semester of the program. The Math 298 course may cover a range of topics intended to smooth the transition from undergraduate- to graduate-level studies in applied mathematics.

Beginning with their second year of graduate studies, all Ph.D. students must have a faculty Research Advisor. Ph.D. students must also establish a thesis committee in consultation with the Research Advisor by the end of their second year of studies.

The Ph.D. thesis committee consists of three to five UC Senate faculty, one of whom must be the student's faculty Research Advisor. Nominations of members who are not UC Senate faculty, e.g., professional researchers or faculty members from other universities, will be considered on an exception-only basis. The Chair of the thesis committee shall always be a member of the Applied Mathematics Graduate Group. At least half of the committee members must be members of the Applied Mathematics Graduate Group. Members of the committee are nominated by the Ph.D. student in consultation with the student's Research Advisor, the faculty in the Graduate Group, and the Graduate Group Chair. These nominations are submitted to the Graduate Division for formal appointment in accordance with Graduate Council policy.

Once the thesis committee has been established, students should meet with the thesis committee at least once a year to report progress towards degree. See Appendix B.1 for a report template. In addition, students are encouraged to meet with their committee members and solicit their feedback well in advance of submitting an official thesis or research proposal.

All members of the committee must be in attendance for Ph.D. qualifying examinations and dissertation defense. If a thesis committee member's absence from campus for an extended period of time makes scheduling of examinations unreasonably difficult, the student may request that the committee be reconstituted. Reconstitution of the committee may also be justified by a substantial change in the student's dissertation topic or may be required by the departure of a committee member from the university. When membership changes must be made, the graduate advisor in consultation with the student should recommend a new committee member, giving the reason for the change. The change must be approved by the Graduate Group Chair in consultation with the Executive Committee.

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For all matters involving advising and mentoring of graduate students that are not mentioned explicitly in this document, please refer to the [UCM Mentoring Guidelines](#).

6) Doctoral Degree Committees:

- a) **Thesis Committee:** The Ph.D. thesis committee consists of three to five UC Senate faculty, one of whom must be the student's faculty Research Advisor. Nominations of members who are not UC Senate faculty, e.g., professional researchers or faculty members from other universities, will be considered on an exception-only basis. The Chair of the thesis committee shall always be a member of the Applied Mathematics Graduate Group. A majority of committee members must be members of the Applied Mathematics Graduate Group. Members of the committee are nominated by the Ph.D. student in consultation with the student's Research Advisor, the faculty in the Graduate Group, and the Graduate Group Chair. These nominations are submitted to the Graduate Division for formal appointment in accordance with Graduate Council policy.

The Thesis Committee is charged with determining the fitness of the student to proceed with the doctoral dissertation through a formal Qualifying Examination. For Qualifying Examination requirements, see item 8) below. The Thesis Committee shall also supervise the preparation and completion of the dissertation and the final examination, including the dissertation defense. For Dissertation and Final Examination requirements, see item 9) below.

- 7) **Advancement to Candidacy:** Before advancing to candidacy for a doctoral degree, a student must have passed the preliminary examinations, must have maintained a minimum GPA of 3.0 in all coursework undertaken, must have passed the Qualifying Examination, and must have completed the following core coursework: Math 221, Math 222, Math 223, Math 231, Math 232, Math 201, and Math 399. Letter-graded core courses must be completed with minimum grades of "B" and a minimum grade point average (GPA) of 3.25. Additionally, the student must either have completed or be currently enrolled in Math 233 and Math 224. Normally, students advance by the end of the sixth semester. The student must file the appropriate paperwork (Advance to Candidacy for the Degree of Doctor Philosophy Form and Conflict of Interest Form) with the Graduate Division and pay the candidacy fee in order to be officially promoted to Ph.D. Candidacy.

8) Qualifying Examination Requirements:

- a. *General Information.* In conjunction with the requirements described in 7) above, passing this exam makes the student eligible for advancement to candidacy. The qualifying exam should be taken by the sixth semester and no later than the eighth semester after admission to the Ph.D. program. There are two components to the qualifying exam, a written research proposal and an oral presentation/exam.

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- b. *Written Research Proposal.* The student must to provide the thesis committee a written research proposal that describes the dissertation research topic, summarizes progress to date, outlines what the student proposes to do, why it is relevant, and what will be learned. This proposal needs to be submitted to the thesis committee at least one month prior to the oral component (part c below). The student must also submit for approval the “Application For Qualifying Examination” form to Graduate Division at least one month prior to the oral component date. The thesis committee will review the research proposal and determine if the student has outlined a project that is deemed appropriate for a Ph.D. If not, the student will be given one month to rewrite the research plan. Once the research plan has been approved, the student may take the oral component of the qualifying exam.
- c. *Oral Component.* The oral component of the qualifying exam consists of two parts. The first part is an oral presentation of the written research proposal. This part is open to the public. The second part is an oral exam, which serves to ascertain the breadth of a student’s comprehension of fundamental facts and principles from his or her graduate course work. This part is closed to the public—only the student and the thesis committee are present.
- d. *Assessment of the Qualifying Exam.* The thesis committee will assess the two parts of the qualifying exam. Each committee member must complete the Thesis Evaluation Rubric form after the exam—see Appendix B.4. The result will be determined by a vote of the thesis committee. The committee will notify the student of the result and immediately thereafter submit this result to the Graduate Division. Possible outcomes of the qualifying examination are:
 - i. PASS (either without or with conditions). A student has passed, with or without conditions, when the thesis committee decides that the student’s performance on both the written and oral components of the exam is satisfactory. The purpose of a conditional pass is to impose additional requirements designed to improve the student’s research efforts. In the case of a conditional pass, possible conditions may include revisions to the written research proposal, an additional oral presentation, additional coursework, or other conditions stipulated by the thesis committee. The thesis committee is given latitude to decide deadlines by which the student will satisfy the conditions. The Chair of the thesis committee is responsible for writing a letter that clearly communicates conditions and deadlines. This letter will be sent to both the Ph.D. student and to Graduate Division. The Chair of the thesis committee is responsible for ensuring that the conditions and deadlines are met.
 - ii. FAIL. A student who has failed the first qualifying examination may work towards a second one. The second examination may have a format different from the first, but the substance should remain the same. A student whose performance on the second attempt is also unsatisfactory, or who does not undertake a second examination within a reasonable period of time, is subject to academic disqualification. A third

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examination may be given only with the approval of the Graduate Group committee and the Vice Provost and Dean of Graduate Education.

- iii. PARTIAL PASS. A student has partially passed when the thesis committee decides that the student passed some components but failed others. In this instance, the following apply:
 1. The student must take a second examination that specifically focuses on the components that were failed in the first examination.
 2. The Chair of the thesis committee must write a letter to the student, with a copy to the Graduate Division, conveying the information about the student's performance (pass, fail, or partial pass) on each of the components covered during the examination.

9) Dissertation Requirements: All students in the Ph.D. Plan are required to defend a dissertation prior to obtaining the Ph.D. degree. The defense consists of written and oral components. The dates for the dissertation defense are arranged between the student and the thesis committee. All members of the thesis committee must be in attendance for the Ph.D. dissertation defense.

- a. *Written Dissertation.* The Ph.D. dissertation must be creative and independent work that can stand the test of peer review. The work must be the student's. It must be original and deemed by the thesis committee to be publishable in an appropriate peer-reviewed journal. The student must submit to the thesis committee all papers containing results from the Ph.D. work on which s/he is an author. The student is encouraged to discuss with members of the thesis committee both the substance and the preparation of the dissertation well in advance of the planned defense date. Detailed instructions on the form of the dissertation and abstract may be obtained from Graduate Division. See Appendix B.5 for a Syllabus for the Dissertation.

The student must provide a copy of the dissertation to each member of the thesis committee, after which each committee member is allowed one month to read and comment on it. The student must also schedule a tentative date for the defense and final examination in consultation with the thesis committee. If one or more committee members believe that there are significant errors or shortcomings in the dissertation or that the scope or nature of the work are not adequate, the student must address these shortcomings and potentially reschedule the defense date.

- b. *Dissertation Defense and Final Examination.* The Ph.D. final exam consists of an open seminar on the dissertation work followed by a closed examination by the thesis committee. During the examination, the student is expected to explain the significance of the research, justify the methods that have been employed, and defend the conclusions of the research. At the conclusion of the examination, the thesis committee shall vote on whether both the written dissertation and the student's performance on the exam are of satisfactory quality to earn a University of California Ph.D. degree. Each committee member must complete

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the Thesis Evaluation Rubric form after the exam – see Appendix B.6. A simple majority is required for a pass. Members of the committee may vote to make passing the exam contingent on corrections and/or revisions to the dissertation. In such a case, the thesis committee will select one member, normally the graduate research advisor, who will be responsible for approving the final version of the dissertation that is filed with Division of Graduate Studies.

The student must submit the signed dissertation in PDF form to the Graduate Chair no later than one month after the final examination date. The student must also file the final dissertation with the Division of Graduate Studies.

- 10) Normative Time to Degree:** For the Ph.D. degree, the normative time to degree is five years, i.e., ten semesters of full-time enrollment. The Normative Time to Advancement to Candidacy is six semesters, and the Normative Time in Candidacy is four semesters.

11) Typical Timeline and Sequence of Events

<i>Year One</i>	<i>Fall</i>	<i>Spring</i>
	<i>Math 221: PDE I</i>	<i>Math 222: PDE II</i>
	<i>Math 231: Num. Sol. Diff. Eqns. I</i>	<i>Math 232: Num. Sol. Diff. Eqns. II</i>
	<i>Math 291: Applied Mathematics Seminar</i>	<i>Math 223: Asymptotics and Perturbation Methods</i>
	<i>Math 201: Teaching and Learning in the Sciences</i>	<i>January: First attempt at passing preliminary exams with scores of 3 on three exams and score of at least 2 on fourth exam.</i>
	<i>Math 399: University Teaching</i>	<i>May: Second and final attempt at passing preliminary exams with scores as above.</i>
	<i>Math 298: Directed Group Study (with Initial Advisor)</i>	<i>Find faculty research advisor and form thesis committee before the beginning of the Fall semester of Year 2.</i>
<i>Year Two</i>	<i>Fall</i>	<i>Spring</i>
	<i>Math 224: Advanced Methods of Applied Mathematics</i>	<i>Math 295: Graduate Research</i>
	<i>Math 233: Scientific Computing</i>	<i>Math 292: Special Topics in Applied Mathematics</i>
	<i>Math 292: Special Topics in Applied Mathematics</i>	
<i>Year Three</i>	<i>Fall</i>	<i>Spring (advancement to PhD candidacy)</i>
	<i>Math 295: Graduate Research</i>	<i>Math 295: Graduate Research</i>
	<i>Qualifying Exam Preparation</i>	<i>Qualifying Exam</i>
<i>Year Four-Five</i>	<i>Dissertation</i>	

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- 12) Sources of Funding:** Graduate students in Applied Mathematics are normally offered financial support through appointment either as a Teaching Assistant (TA), Teaching Fellow (TF), and/or Graduate Student Researcher (GSR).

Students in their first semester of residence usually serve as TAs for appropriate courses in the schools of Natural Sciences or Engineering. After the first semester, support may be offered through either funding as a TA or a GSR in the graduate research adviser's group. Graduate students with external fellowships are still required to satisfy the teaching requirement and will be paid by the school for teaching. While every effort will be made to provide employment as a TA, Teaching Fellow, or GSR for all graduate students in residence, admission to graduate studies carries no guarantee of financial support beyond that specified in the initial letter of commitment of financial support (if any). During the academic year, appointments are limited to 49.9% time. During academic breaks and summer months, students may be appointed at 100% time when research funds to support additional GSR support are available. Finally, to receive financial support from the university, students must be in good academic standing.

- 13) Leaving the Program Prior to Completion of the PhD Requirements:** Students in good academic standing and who obtained scores of at least 2 on all preliminary exams may petition to move from the Ph.D. to M.S. program and pursue a terminal M.S. degree. A student working towards a Ph.D., who completes the M.S. requirements (either Plan I or Plan II), may petition to be awarded the M.S. degree. Additionally, a Ph.D. student, who has been in residence for at least two semesters, is in good academic standing, and has completed at least three of the core courses, may petition the Admissions Committee to pursue a terminal M.S. degree.

D. General Information

- 1) PELP, In Absentia and Filing Fee status.** Information about PELP (Planned Educational Leave Program), In Absentia (reduced fees when researching out of state), and Filing Fee status can be found in the Graduate Group Policies and Procedures Handbook available on Graduate Division. The Applied Mathematics Graduate Program only accepts full-time students. Exceptions will be only granted for students in the non-thesis M.S. degree program with the permission of the chair of the graduate program, in consultation with the Executive Committee.