

Morgan State University



School of Graduate Studies Catalog 2014-2015

School and College Sections

SCHOOL OF COMPUTER, MATHEMATICAL & NATURAL SCIENCES

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Changes are effected from time to time in the general regulations and in the academic requirements. There are established procedures for making changes and procedures which protect the institution's integrity and welfare. A curriculum or graduation requirement, when altered, is not made retroactive unless the alteration can be accommodated within the span of years required for graduation. Additionally, because of space limitations in limited enrollment programs, Morgan State University may not be able to offer admission to all qualified students applying to these programs and/or class-sections.

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SCHOOL OF COMPUTER, MATHEMATICAL & NATURAL SCIENCES

OFFICERS OF ADMINISTRATION

Alvin P. Kennedy, Ph.D.

Interim Dean and Professor of Chemistry
School of Computer, Mathematical and Natural Sciences
Richard N. Dixon Science Research Center, Room 200
Tel: (443) 885-4515; Fax: (443) 885-8215
E-Mail: alvin.kennedy@morgan.edu

Kadir Aslan, Ph.D.

Assistant Dean for Research and Graduate Studies and Professor
School of Computer, Mathematical and Natural Sciences
Richard N. Dixon Science Research Center, Room 200
Tel: (443) 885-4515; Fax: (443) 885-8215
E-Mail: kadir.aslan@morgan.edu

DOCTOR OF PHILOSOPHY—BIOENVIRONMENTAL SCIENCES (Ph.D.)

Office of the Dean

School of Computer, Mathematical and Natural Sciences
Richard N. Dixon Science Research Center, Room 200
Tel: (443) 885-4515; Fax: (443) 885-8215
E-Mail: alvin.kennedy@morgan.edu

Michael Koban, Ph.D.

Graduate Program Coordinator
School of Computer, Mathematical and Natural Sciences
Richard N. Dixon Science Research Center, Room 200
Tel: (443) 885-4515; Fax: (443) 885-8215
E-Mail: michael.koban@morgan.edu

Goal

Bioenvironmental Science is defined as “the systematic study of the interactions between biological systems and the environment using innovative applied research tools and fundamental research”. The biological systems include, human beings, animals, plants and bacteria, where water, air, ground, space and indoors are defined as the environment.

Morgan State University’s Ph.D. program in Bioenvironmental Science is the one of the two Ph.D. programs at the School of Computer, Mathematical and Natural Sciences (SCMNS) and is the only such program in Maryland’s higher education system. The Ph.D. program in Bioenvironmental Science program at Morgan integrates strong academic training, fundamental and applied research practices through interdisciplinary efforts with participating faculty from the Departments of Biology, Chemistry,

Physics, Mathematics, and Computer Science into a cohesive program of study that focuses on an array of environmental issues that affect biological systems. Specifically, our goals are:

- To provide graduate students with essential academic knowledge, research and practical skills needed for successful careers in Bioenvironmental Science related jobs at various private institutions, government agencies, academia, and industry. This will be accomplished by: training students on the interaction between various components/systems of the environment and how to protect the health of humans in the changing environment;
- Educating students on the importance of gene–environment and behavior-environment interactions in the development and homeostasis of biological organisms; Providing interdisciplinary and multidisciplinary research training that addresses the understanding of the underlying mechanism by which physical, chemical, and biological agents cause alterations in ecosystem integrity and cause morbidity and mortality in humans, animals, and other organisms, especially those of commercial value; Training students in the development of cost-effective methodologies whereby the impact of various environmental pollutants and toxic substances may be prevented and/or controlled;
- Establishing partnerships with other research-intensive universities, government agencies, international organizations and the private sector that will provide training and internships to facilitate applied research activity and future career opportunities for students;
- Establishing community outreach programs that provide awareness regarding the impact of physical, chemical, biological, and toxic agents generated by natural or anthropogenic events on human health.

General Program Description

The Ph.D. in Bioenvironmental Sciences is a full-time program of study offering research opportunities and instruction in five suggested general areas of concentration: Environmental Toxicology, Environmental Science, Environmental Chemistry, Environmental Health Sciences, and Environmental Biotechnology. The courses offered in the program are primarily for doctoral students, however, students enrolled in the Master's degree programs may participate. For example, Biology, Chemistry, and Engineering majors can enroll in suitable 500 and 600 level Bio-Environmental Science graduate courses for credit toward their degrees. The consent of the chairperson of the student's major department is also required. Students in the Bioenvironmental Sciences Program need to seek approval of their Graduate Program Coordinator in order to take credits outside of SCMNS. Students are furthermore strongly advised to consult with their academic (dissertation) advisors and the Graduate Program Coordinator prior to finalizing their registration each semester. Incoming students, who have not yet been assigned a faculty advisor, must seek approval for all course registration from the Graduate Program Coordinator.

General Preparatory Requirements

Students interested in the Ph.D. Program in Bioenvironmental Science must have a strong background in basic sciences including biology, physics, chemistry, and mathematics. Course work in statistics and competence with computers are particularly important for perspective students.

Admission Requirements

Graduate Admissions is a four-step process:

1. Applicant submits all required documentation to the School of Graduate Studies (SGS);
2. Completed folder is forwarded to the Graduate Program Coordinator for review by program admission committee.

3. Program admissions committee reviews application and forwards “Admit” or “Deny” decision to the Dean of SCMNS and subsequently to SGS,
4. Following admit or denial decision by program committee, the Dean of the SGS sends official decision by mail.

A. Documents required for complete application:

- A bachelor’s degree from an accredited college or university.
- Official transcript showing undergraduate cumulative grade point average G.P.A. of 3.0 or better for unconditional admission.
- Transcripts showing completed minimum course work.
- An application for admission together with official copies of transcripts from all graduate and undergraduate institutions attended.
- Test scores (for those programs requiring them) on the Graduate Record Examination (GRE). Test scores may not be more than 5 years old prior to the date of application.
- Three letters of recommendation (preferably from faculty members of institutions previously attended)
- A one-page typed personal statement of academic and professional plans and the reasons for selecting Morgan State University.

B. International students must also include the following documents:

- An evaluation of the applicant’s credentials from Educational Credential Evaluators, Inc., (ECE) P.O. Box 92920, Milwaukee, Wisconsin 53202-0970, or from World Educational Services (WES), P.O. Box 745, Old Chelsea Station, New York, NY 100113-0745.
- Scores from the Test of English as a Foreign Language (TOEFL). The minimum paper-based test score required for admission is 500. Minimum TOEFL (internet based test) scores:
 - Reading (15)
 - Listening (15)
 - Speaking (15)
 - Writing (15)
 - Total Score: 60
 - TOEFL scores are not required for applicants from the British Commonwealth, Australia, Canada, Great Britain, West Indies, New Zealand, South Africa, Nigeria, Kenya, and Tanzania).

C. Required Student and Exchange Visitor Information System (SEVIS) Documentation

- International Supplemental Form
- Financial Certificate showing funds sufficient to cover first year’s tuition
- Recent bank statements for last 6 months with the balance equal to or greater than that set by the School of Graduate Studies as the Cost of Attendance (see the SGS web site for details).
- Notarized letter of sponsorship if the student is using another person’s financial information as documentation for their I-20.
- Transfer Eligibility Form if student attended a US college or university. This does not apply if the previous degree is from Morgan State University. The student’s electronic SEVIS record must be transferred to Morgan State University by the previous institution.

Degree Program Requirements

General

Students are bound by the requirements stated in the catalog in effect when they enter the Doctor of Philosophy (Ph.D.) in Bioenvironmental Science graduate program. They are designed to complement policies and procedures promulgated by the departments and programs within the SCMNS and also those of the SGS.

A sequence of events, beginning with the first semester of graduate study and culminating in the submission of an approved thesis or dissertation to the SCMNS and to the SGS, is outlined herein to guide the student, Research Advisor, and all pertinent members of the SCMNS community towards expeditious completion of degree requirements.

The orderly sequence of milestone events during the tenure of the graduate student will be as follows (see the flow chart):

1. Preparation of graduate student dossier.
2. Completion of program Core Courses.
3. Completion of Research Rotations (if necessary).
4. Selection of thesis/dissertation Research Advisor.
5. Pass comprehensive written qualifying examination.
6. Advancement to degree candidacy
7. Organization of thesis/dissertation Graduate Advisory Committee.
8. Preparation and presentation of thesis/dissertation Research Proposal as a seminar to the Graduate Advisory Committee, outside evaluator(s), and other members of SCMNS as appropriate. This will constitute the Oral Examination.
9. Completion of elective courses.
10. Completion of original research and writing of thesis/dissertation under guidance of the student's Graduate Advisory Committee.
11. Approval of thesis/dissertation by Graduate Advisory Committee, including outside evaluator(s). Approval of thesis/dissertation by the Associate/Assistant Dean for Research and Graduate Studies and Dean of SCMNS.
12. Schedule thesis/dissertation defense, and public seminar of thesis/dissertation research followed by closed-session defense of thesis/dissertation by Graduate Advisory Committee and special invitees.
13. Sign-off of thesis/dissertation by Office of the Dean, SCMNS, and submission of documents to the SGS.

There are several milestone events at which point a graduate student can be dismissed from the program. They are: the student (1) repeatedly fails one or more Core Courses; (2) does not select a Research Advisor after advancing to the degree candidacy; (3) fails the written comprehensive qualifying examination twice; or (4) does not present an acceptable research proposal and fails the oral examination.

To ensure appropriate quality control and accountability, every milestone event has a specific form that must be filled out and kept on record. Instructions are found on each form for requisite signatures and routing for filing of copies.

Duties and Responsibilities of the Graduate Program Coordinator

1. Provides advice and support to students on a range of academic matters.
2. Serves as liaison between students and faculty and/or administration, as necessary.
3. Reviews and screens credentials of prospective students, and assists in processing applications.
4. Coordinates and assists with student recruitment, admission, registration, and other activities pertaining to student advancement within the program.
5. Advises students on degree requirements (e.g., departmental comprehensive examination) and their associated timelines.
6. Prepares class schedules and catalogs; develops recruitment and retention materials for the program.
7. Develops and maintains comprehensive student records and databases to monitor student progress in relation to program requirements, and expeditiously correspond with students regarding problems and deficiencies.
8. Coordinates and participates in the recruitment and administration of graduate assistants and teaching assistants.
9. Ensures that university policies and standards are met in relation to grades, graduation requirements, admissions, withdrawals, and associated issues.
10. Coordinates preparation and timely administration of departmental or programmatic Comprehensive Qualifying Examination.
11. Regularly conducts an audit of the student's academic records to make certain that Core and elective courses are satisfactorily completed and grades have been correctly inputted.

An important task of the Graduate Program Coordinator is to liaison with the SGS to not only review application packages, but to act as a champion for those applicants who are awarded financial aid. Because applicants may oftentimes not receive timely notification of financial aid, the Graduate Program Coordinator must, either by direct person-to-person, telephone, or e-mail contact, discuss the conditions by which financial aid is given. At the same time, the Graduate Program Coordinator should determine the level of serious interest the prospective student has in coming to Morgan State University, as this may have consequences for course offerings, Research Rotations (as applicable), and placement in laboratories for thesis or dissertation re-search.

The matriculation date is typically the fall semester; however, some applicants, depending upon circumstances, may gain entry to a graduate program during the spring term. Irrespective of the entry date, the Assistant/Associate Dean for Research and Graduate Studies will convene a meeting of all SCMNS Graduate and/or Program Coordinators prior to the beginning of each new semester, and including the summer session should conditions warrant. The general agenda for these meetings will be:

New business:

- Commitment new applicants to attend MSU
- Financial aid packages to new applicants
- Possible mentor and mentee matchups of new applicants

Old business:

- Detailed status of current graduate students
- Problems and their resolutions
- Tracking of Morgan-degreed graduate students

All correspondence by Graduate Program Coordinators must be copied to the Assistant/Associate Dean for Research and Graduate Studies of the SCMNS. All Graduate Program Coordinators report to the Assistant/Associate Dean for Research and Graduate Studies.

Issues and concerns within a graduate program that cannot be resolved at the level of the Assistant/Associate Dean for Research and Graduate Studies should be escalated to the Dean's office and subsequently to the SGS.

Graduate Student Dossier

Upon matriculation into the graduate program, the departmental Graduate Program Coordinator will meet with the graduate student and open a dossier which will be regularly updated with appropriate information, documents, and forms pertinent to the student's program of study. Included in the dossier will be copies of the application forms, transcripts (official or unofficial), letters of recommendation, etc. The purpose of having this initial body of information is for prospective research advisors to evaluate the student's academic history.

Additionally, at the end of each semester (including summer terms if applicable), a complete and accurate print-out of the graduate student's grades for all courses taken must be put into the dossier. This activity is necessary so as to obviate any unexpected problems involving the completion of an audit of the student's academic record prior to graduation.

Minutes and recommendations of meetings of the student's Graduate Advisory Committee are also to be maintained in the dossier.

This dossier will be kept in active form until notification is received from the SGS that the student has successfully completed all requirements for the graduate program and that the degree has been granted. Thereafter, the dossier will be kept permanently in an archival file pool.

At the time of the first meeting with the student, the Graduate Program Coordinator will give hard copies of handbooks on Policies and Procedures for Graduate Programs of the SCMNS, and of the departmental and/or specific program. The Graduate Program Coordinator will also direct the student to the SGS website where additional important information about graduate degree requirements can be found. A point of emphasis will be the critical timelines that must be followed as the student approaches and enters the final semester of study, concluding with the presentation of a thesis or dissertation, its approval, and successful oral defense of the body of work contained therein.

It is the responsibility of the Graduate Program Coordinator to keep copies and/or originals of all requisite departmental and SCMNS forms that certify and track progress in the degree program within the student dossier. The dossiers must be kept in a secure location and should be considered confidential.

Continuous Registration

The student must register continuously for courses, 600 level or above, (minimum of 3 hours) from the time the doctoral research proposal is approved, admission to candidacy is accepted, registration for 600 level courses is begun, whichever comes first, including the semester in which the dissertation is approved and accepted by the SGS.

Core courses

Each program of the SCMNS has an established set of required Core Courses. It is the responsibility of the graduate student and the Graduate Program Coordinator (and later, the Graduate Advisory Committee) to determine the sequence of Core Courses to take, as well as appropriate elective courses germane to the student's research interests.

It is possible that students may enter a program of study already having taken one or more courses equivalent to those in the prescribed Core requirements. In such instances, it is the responsibility of the student and the Graduate Program Coordinator to deliver appropriate documentation to the Assistant/Associate Dean for Research and Graduate Studies, SCMNS, and to the Dean of the SGS to obtain waiver or exemption from the Core Course(s). For this process, the Application for Transfer Credits form, available from the SGS, is to be used. Documentation of such waiver will be kept by the Graduate Program Coordinator in the student's dossier. Please note that it is the firm policy of the SGS that no graduate credits can be transferred from a foreign college or university to Morgan State University.

Typically, Ph.D. students should complete them by the end of the second year.

Core and elective courses must be conducted at the graduate level. Any textbook(s) used must meet the approval of the departmental Chairperson in consultation of the Assistant/Associate Dean for Research and Graduate Studies. This requirement is predicated on the happenstance when a contractual instructor used a textbook that was inappropriate for a graduate course and which later handicapped some students at the time of the Comprehensive Qualifying Examination.

Upon successful completion of Core Courses, the Graduate Program Coordinator will endorse this milestone using the Certification of Completion of Core Courses form. There are five (5) + one (1) core course requirements and seminar course to be taken at least four (4) times for the Ph.D. Bioenvironmental Science.

Course	Credits
BIOL 525: Cellular Biology	3
BIOL 639: Fundamentals of Bioenvironmental Sciences	3
BIOL 607: Toxicology of Biological Systems	3
CHEM 600: Advances in Biochemistry	3
CHEM 601: Environmental Chemistry	3
BIOL 625: Seminar in Bioenvironmental Science (4X1 Credit)	4

- Please note that BIOL 631 (Bioethics & Communications) is a requirement for all students. This class is to be taken immediately following completion of the student's Comprehensive Examination and will aid with the preparation of the dissertation proposal.

Suggested areas of concentrations:**Environmental Toxicology**

BIOL 526: Molecular Biology	3
BIOL 602: Environmental Immunotoxicology	3
BIOL 626: Environmental Physiology of Plants	3
BIOL 627: Molecular Toxicology of Diseases	3
BIOL 628: Environmental Carcinogenesis	3
BIOL 629: Developmental Neurotoxicology	3

CHEM 602: Analytical Techniques in Environmental Chemistry 3
Electives and Seminars (To Be Determined)

Environmental Chemistry

CHEM 533: Statistical Methods in Analytical Chemistry 3
 CHEM 551: Advanced Organic 3
 CHEM 581: Techniques in Chemistry 3
 CHEM 602: Analytical Techniques in Environmental Chemistry 3
 CHEM 603: Physical Chemistry of Environmental Sciences 3
Electives and Seminars (To Be Determined)

Environmental Science

BIOL 521: Bioecology 3
 BIOL 603: Marine and Aquatic Biology 4
 BIOL 604: Ecosystem Analysis 4
 BIOL 606: Environmental Toxicology 3
 BIOL 609: Environmental Microbiology 3
 BIOL 626: Environmental Physiology of Plants 3
Electives and Seminars (To Be Determined)

Environmental Health Science

BIOL 610: Molecular Epidemiology of Infectious Diseases 3
 BIOL 611: Food & Water Borne Diseases 3
 BIOL 624: Environmental Biotechnology 3
 BIOL 627: Molecular Toxicology of Diseases 3
 BIOL 628: Environmental Carcinogenesis 3
 BIOL 629: Developmental Neurotoxicology 3
Electives and Seminars (To Be Determined)

Environmental Biotechnology

BIOL 601: Molecular Biotechnology 3
 BIOL 605: Dynamic Computer Modeling 3
 BIOL 606: Environmental Toxicology 3
 BIOL 620: Environmental Genetics 3
 BIOL 621: Microbial Biochemistry 3
 BIOL 624: Environmental Biotechnology 3
Electives and Seminars (To Be Determined)

Research Rotations

During the first year, each doctoral student is required to complete up to three Research Rotations in the laboratories of research and graduate faculty members of their choice. Each Rotation will last for no more than 3 months (i.e. fall semester, spring semester and summer) and is intended to assist in the process of selecting a Research Advisor and dissertation research area. These Research Rotations should offer the student the opportunity to explore multiple disciplines as they relate to Bioenvironmental Science. Research Rotations placement must meet the approval of the Graduate Program Coordinator, and the Assistant/Associate Dean for Research and Graduate Studies.

A student who enters the Bioenvironmental Science program with a Master's degree in an appropriate area of study may already have research experience. In such a case, the student may be exempted from having to take three Research Rotations; up to two may be sufficient. To qualify for exemption, the student must provide documentation that demonstrates laboratory or field research experience (i.e., published peer-reviewed research papers, book chapters and invited oral presentations) to the Graduate Program Coordinator and the Assistant/Associate Dean for Research and Graduate Studies. Upon review, the Assistant/Associate Dean for Research and Graduate Studies will write an official memorandum exempting the student from one or more Research Rotations. In rare instances, where the student has demonstrated extensive research experience, as supported by the letters of references and has selected a Research Advisor, the student will be exempted from all Research Rotations allowing the student to start his/her initial research activities immediately.

The Ph.D. student will enroll in BIOL/CHEM 800-802, Supervised Doctoral Research for 3 credit hours for each Research Rotation. The three Rotations are BIOL/CHEM 800, 801, and 802; a total of 9 credit hours will be earned by the end of the Rotations. It is expected that the student will spend no less than 20 hours per week in the laboratory. The student is required to present research findings in an informal seminar to supervising faculty, members of the laboratory, and respective Graduate Program Coordinator. The Ph.D. student will be graded for each Research Rotation as follows: a grade of "A" is considered superior, "B" is average, and both "C" and "F" are failing grades.

General Guidelines for Research Rotation

For a Research Rotation to be a meaningful training experience, the process should be appropriately structured and each graduate faculty member should have several feasible projects on hand. The following will be expected of the faculty during each Rotation:

- 1) Prepare a list of review and research papers to help guide and orient the student to the research area or topic of interest.
- 2) Develop a clearly defined research project which emphasizes acquisition of technical as well as critical thinking skills.
- 3) Prepare a detailed timeline for the Rotation and reasonable expectations.
- 4) Schedule at least once-weekly meetings with the student to discuss papers, research progress, data analysis and interpretation, etc.
- 5) Actively train the student in the scientific method (e.g., hypothesis testing, use of controls, etc.) and new techniques.
- 6) Closely and objectively monitor the student's progress in research and skills development.
- 7) Prepare a report using the Faculty's Evaluation of Graduate Student Research Rotation (see below).

Students should write a memorandum to the respective Graduate Program Coordinator before each Rotation with a first and second choice of Research Rotation labs. The faculty member must have given consent to accepting the student for the Rotation and have sufficient resources to support the student throughout the research project. Should a problem arise, the Graduate Program Coordinator will discuss the matter with the student, respective member faculty, and the Assistant/Associate Dean for Research and Graduate Studies to expeditiously resolve the issue(s).

At the end of each Research Rotation, there will be a formal evaluation of the student's progress and research capabilities. The faculty supervising the Research Rotation will complete the Faculty's Evaluation of Graduate Student Research Rotation form. The student will also be expected to complete an

evaluation of the faculty member's teaching and mentoring during the Rotation, using the Graduate Student's Evaluation of Research Rotation form. The completed forms will be kept by the Graduate Program Coordinator.

It may be the collective judgment of Research Rotation faculty that the student may not sufficiently demonstrate capabilities of conducting high-level research. In such an instance, the Research Rotation faculty members must convene a formal meeting to objectively discuss whether or not the student should continue forward with the graduate program or study, or, if the student should be dismissed. Also in attendance of such a meeting should be the Graduate Program Coordinator and the Assistant/Associate Dean for Research and Graduate Studies. Two courses of action are envisaged: First, a remedial program of study may be recommended, with additional coursework and/or another Research Rotation. If the student accepts this outcome, stringent and continuous follow-ups are required. Unsatisfactory progress, which will be reviewed by the program Graduate Program Coordinator and the Assistant/Associate Dean for Research and Graduate Studies can result in the student's dismissal. In such instances, in consultation with the Deans of SCMNS and SGS, the Assistant/Associate Dean for Research and Graduate Studies will write a letter of dismissal to the student.

Selection of Research Advisor

Doctoral students in the Bioenvironmental Science program, after having satisfactorily completed up to three Research Rotations, and by no later than the first week of October 1st of the second year in the program, will choose a research area and Research Advisor for dissertation research.

Mutual agreement between the student and the Research Advisor must be evident, and requires the approval of the departmental Graduate Program Coordinator and the Assistant/Associate Dean for Research and Graduate Studies. The faculty member should have an active research program, as evidenced by current funding and productive research. It is realized, however, that in some instances funding may not necessarily be required to conduct and complete the proposed research project.

A Research Advisor must have certain qualifications that are required by the SGS. To review the criteria, please go to: <http://www.morgan.edu/academics/Grad-Studies/faculty.asp>

To be a Research Advisor for doctoral degree students, full membership as Graduate Faculty is necessary. Being an associate member of the Graduate Faculty makes one eligible to be Research Advisor only for the Master's degree level; however, he/she may serve on a doctoral committee. Occasionally, there may be special circumstances whereby a Visiting, Adjunct, or Research Professor may be approved to guide and advise a doctoral student. Such a request will be granted if the person has a distinguished record of scholarly achievement and, as applicable, funds are available to support the proposed research for the duration of the project.

Additionally, to be a Research Advisor, SCMNS faculty must be actively and continuously engaged in scholarly activities. Scholarly activities are defined as one or more of the following:

- Publishing scientific papers in peer-reviewed professional journals of high caliber within the past five years, and with a good record of being cited by other scholars in the research literature.
- Publishing and/or editing textbook(s), reference book(s), or monograph(s) in his/her discipline.
- Being a referee for manuscripts submitted to professional journals of high caliber, or being on the journal editorial board.

- Regular invitations to give seminars and/or workshops at other institutions of higher learning or during a national or international meeting of a professional scientific society.
- Contributing significantly to the development of graduate courses by improving their content, introducing new areas of concentration, or developing effective pedagogy.

A SCMNS faculty who has been a full-time instructor or lecturer in undergraduate and/or graduate courses, but not actively engaged in research may not be a Research Advisor.

The duty of the Research Advisor is to oversee and ensure that the graduate student's research is original, of the highest quality, that progress is timely, and proper scientific conduct was employed. The student and Research Advisor will sign a document of commitment to be approved by Graduate Program Coordinator, Department Chairperson, and the Assistant/Associate Dean for Research and Graduate Studies.

For this activity, the Selection of Graduate Research Advisor form is to be used.

The Written Comprehensive Examination

The written comprehensive qualifying examination must be taken during the first summer (end of the initial two semesters) following satisfactory completion of all required five Core Courses. In the event that a student fails a Core Course, but has performed well in other Core Courses (with grades of A or B), the decision to allow the student to take the comprehensive examination will be made by the Graduate Program Coordinator and the Assistant/Associate Dean for Research and Graduate Studies and may be granted a second attempt within the next Fall semester (third semester). Comprehensive examinations must be concluded within the third semester of the student's enrollment and prior to the approval of the student's thesis/dissertation proposal without any exceptions.

The written comprehensive examination will consist of a common pool of questions for all students derived from coursework. This examination should fulfill two general objectives: First, to serve as an educational vehicle to enhance the training of students, and second, to allow the faculty to assess whether students are sufficiently prepared to progress to the next phase of the graduate program.

In addition, the exams will evaluate the ability of the students to (1) formulate scientific hypotheses or develop methods to solve those problems, (2) design and interpret scientific experiments, and (3) write clearly and persuasively.

Determination of the passing score will be at the discretion of each department or program, but in general, should be no less than 80%. To mitigate any question of uneven grading, faculty who contribute questions must provide to the Graduate Program Coordinator an outline of idealized answers. This will serve as a benchmark for scoring purposes.

If a student fails the written comprehensive examination in its entirety or a section of it, he/she must satisfactorily pass the failed section(s) within the third semester student's enrollment. A second failure of the entire exam will result in dismissal from the program.

To document this milestone, the Certification of Completion of the Written Comprehensive Qualifying Examination form is to be completed.

Advancement to Candidacy

Following successful completion all Core Courses, Research Rotations (if applicable), selection of a Research Advisor, passing the Written Comprehensive Qualifying Examination, and maintaining a 3.0 or better grade point average in all graduate coursework, the graduate student is ready to be advanced to candidacy in his/her degree program. This activity is documented with the Certification of Advancement to Candidacy form.

Advancement to candidacy means that with the exception of taking elective courses and discharging specific requirements of his/her degree program (e.g., teaching activities), the graduate student engages in full-time research. The culmination of research must result in a doctoral dissertation that meets all the requirements of the SCMNS and SGS.

Satisfactory Progress

To continue in a degree program a student must make satisfactory progress towards the degree. If the Graduate Committee determines that satisfactory progress is not being made, a student may be required to withdraw because of academic deficiency. Students may appeal this decision with the appropriate Morgan State University Academic and Status Degrees Committee.

A candidate for the Ph.D. program must complete a minimum of 33 hours of graduate coursework beyond the master's degree and a minimum of 60 hours of graduate course work beyond the baccalaureate degree. A minimum of 18 semester hours of the student's coursework must be Morgan courses at the 600 levels, exclusive of dissertation hours. In addition, a minimum of 6 hours of the course 800, 801, 802 (Doctoral Research) is required during the first year of the student's tenure within the program and prior to the completion of the Written Comprehensive Examination. Following the successful completion of the Written Comprehensive Examination, the student may enroll in BIOL or CHEM 995 (Fall), 996 (Spring), Dissertation Research. These credits may be taken repeatedly as needed for the duration of the student's work on her/his dissertation. As the student progresses in her/his work, BIOL 997 (Dissertation Guidance) may be taken in combination with either BIOL 995 or 996. The student may enroll in BIOL 997 repeatedly. Within the final stages of dissertation completion, but at least 12 month prior to graduation, the student must enroll and successfully complete BIOL 998 (6 credits). This class is only taken once.

Teaching Requirement

As a requirement for graduation, all Ph.D. candidates must satisfactorily complete at least two academic semester of teaching assistant (TA) duties in a department appropriate to the student's area of concentration, preferably within the first year of enrollment. Discharge of this requirement will be scheduled by mutual agreement between the student, major advisor, Graduate Program Coordinator and the Department Chair. The Chair will act upon the request based on the Department's anticipated teaching need and the availability of tuition credits. The Department Chair will also certify that the TA assignment fulfills the requirements. The instructor of the course in which the student is involved will certify that the student has satisfactorily discharged the TA duties and has met the teaching requirements as listed below. The completed original certification form is kept in the student's file.

The TA requirement may be discharged by activities related to either undergraduate labs or recitations in which the principal activity of the TA is instruction rather than grading or logistical support. The ideal TA experience would integrate a number of aspects of teaching including lectures and/or demonstrations, student evaluations (testing), and grading.

Organization of Graduate Advisory Committee

After satisfactory completion of the written comprehensive qualifying examination, the graduate student will organize his/her Graduate Advisory Committee. This Committee is responsible for:

- guiding student research and thesis/dissertation development;
- providing objective scientific and project management advice to student-advisor teams;
- approval of the doctoral dissertation proposal;
- advising the student on remaining course work;
- advising the student on ethical conduct of research;
- editorial guidance during writing of the dissertation;
- overseeing the thesis or dissertation oral defense;
- approval of the dissertation.

The members of the Graduate Advisory Committee will be selected by the student in consultation with his/her Research Advisor. All Committee members must be approved by the departmental chairperson, Graduate Program Coordinator, the Assistant/Associate Dean for Research and Graduate Studies, and Dean of SCMNS.

For the Ph.D. degree, it is required to have at least five members. No less than one-half or the majority of committee members should be Full Members of the Graduate Faculty. The remaining committee members can be MSU faculty who are Associate Members of the Graduate Faculty. At least one member of the committee should be an “external examiner.” By this, it is meant that the person is from a different department or program of MSU that is allied to the student’s area of study, or ideally, a person external to the University and having appropriate scientific expertise.

Irrespective of whether the external examiner is a MSU faculty person or one from outside the MSU community, he/she should agree to discharge the responsibilities itemized above without consideration of remuneration for his/her time and services. If the external committee member is not a MSU faculty, it is appropriate to provide a meal, parking, and other courtesies while attending Graduate Advisory Committee meetings or functions related to the student’s program of study. It may be that the external committee member is from a location that requires more than routine travel and possibly overnight stay(s). It is also conceivable that the person requires consultancy fees. In such a case, it is the responsibility of the Research Advisor to secure funds to accommodate all such expenses incurred by the external committee member. It is expected that an MSU community person who serves as an external committee member will indicate such on his/her annual report.

The Research Advisor, whose role in the actual performance of the thesis or dissertation research is essential, will NOT serve as the Chair of the Graduate Advisory Committee. The Chair of the Graduate Advisory Committee shall be elected from among the committee members and must be a Full Member of the Graduate Faculty. Approval of the composition of the Graduate Advisory Committee will be the responsibility of the Assistant/Associate Dean for Research and Graduate Studies, and Dean of SCMNS and the Graduate Advisory Committee Approval form is to be used.

The duties and responsibilities of the Graduate Advisory Committee Chairperson are:

- To provide objective oversight and ensure adherence to policies and procedures as stipulated by the SGS and SCMNS.

- In consultation with the Research Advisor, establish realistic milestones for determination of progress.
- To work cooperatively and in consultation with the graduate student and the Research Advisor, to convene and preside over committee meetings. Meetings should be scheduled at least twice per year and possibly more frequently thereafter as the student approaches completion of degree requirements.
- To ensure the recording of detailed minutes of each meeting, circulate them for approval by committee members, and submit said minutes to the departmental Graduate Coordinator, and Director of Graduate Studies.
- To review objectives, determine rate of progress, and make changes to milestones when necessary to overcome obstacles that may impede student progress. The Committee Chair must communicate all Graduate Advisory Committee decisions to the departmental Graduate Program Coordinator.
- To ensure that the thesis or dissertation quality, content, and style meet the established requirements as promulgated by the Department or program, SCMNS, and SGS.
- Provide copies of the Policies and Procedures manual for SCMNS graduate programs and associated forms to each committee member who is not a faculty of Morgan State University so that he/she/they are in duly aware of them.

The Graduate Advisory Committee must meet once per semester to review the student's progress and to provide guidance so that timely program requirements and milestones are met. This activity is to be documented using the Graduate Advisory Committee Meeting Summary and Progress Report form.

Research Proposal and Oral Examination

All graduate programs in the SCMNS require a thesis or dissertation to be submitted for satisfactory completion of degree requirements. This document embodies a specific and scholarly research problem undertaken by the student through the guidance of his/her Research Advisor and members of the Graduate Advisory Committee, and must be of very high quality.

The nature of scientific research demands that there be a good fit between the faculty Research Advisor and the student. It is therefore necessary for the student to have a genuine interest in the research activities of the faculty member, and in turn, the faculty must be willing to mentor and guide the student toward successful completion of a graduate degree. As already stated, a major prelude to this stage in the student's tenure is the Research Rotation; however, it is realized that not all SCMNS graduate programs would entail Research Rotations. Further, the form, Selection of Graduate Research Advisor, signifies the mentor/mentee relationship.

A major part of graduate training is the preparation of a Research Proposal to demonstrate his/her scholarship and academic preparedness. It is expected that the Research Proposal will be a well-thought out document of very high quality. The proposed research project or problem must be original, novel, and where appropriate, hypothesis-driven. It is understood that in some fields such as Mathematics, the research may be introduced as a statement of a problem and demonstrating an alternate means of solving that problem. In any case, the student's Research Proposal should be organized similar to an application for research funds, such as those to the National Institutes of Health, the National Science Foundation, other Federal and State granting agencies, private foundations, and professional organizations.

It is recommended that all Research Proposals are prepared within the guidelines described for a NIH RO1 research proposal (<http://grants.nih.gov/grants/funding/r01.htm>). In general, the Research Proposal should consist of all or most of the following elements:

- Abstract or summary of the Research Proposal.
- Introduction, where the relevant past and current research literature is to be cogently summarized with identification of gaps in current knowledge.
- Statement of the problem or hypothesis.
- Specific aims of the Research Proposal.
- Preliminary data and results, if applicable.
- Scientific approach and methods to be used in conducting the research, and rationalization or justification of each, including realistic timelines.
- Expected results.
- Identification of potential pitfalls and suggestions for alternative approaches.

Because the goal is to have graduate programs of excellence, it becomes necessary that the student and his/her Research Advisor select a project that will result in scholarly work. Specifically, for doctoral students (e.g., Bioenvironmental Science), their dissertation should culminate in at least two or more published peer-reviewed journal articles.

The graduate student, in consultation with his/her Graduate Advisory Committee, should have (an) external referee(s) who will critically but objectively read the Research Proposal and provide input as appropriate. The external referee(s) must be a person(s) of high academic repute from outside the Morgan State University community whose expertise can further provide quality control measures to the SCMNS graduate programs. It is not intended that the external referee(s) will supplant the responsibilities of the Research Advisor or other members of the Graduate Advisory Committee, but rather, to complement them.

Oral Examination

The Oral Examination will consist of a defense of the student's Research Proposal and questions pertaining to his/her specific area of concentration. This will be done in the form of a seminar of the Research Proposal. The Research Proposal seminar will be an open forum for all faculty and students; however, only the candidate's Graduate Advisory Committee members and external referee(s) will be responsible for scoring the candidate on the oral defense of the Research Proposal. The Chairperson of the Graduate Advisory Committee will take minutes of the meeting.

There are three possible outcomes stemming from the submission of the Research Proposal and the Oral Examination.

- The student may pass unconditionally, and thereafter engages in full time research.
- The student may pass conditionally. This means that some component of the Research Proposal and/or Oral Examination was not satisfactory. In such an event, the issues and problems must be succinctly written in the form of a report. The student must then agree to abide by the findings if he/she wishes to continue with the program of study. The student will have one month to correct the problem(s) and resubmit a revised Research Proposal. Another Oral Examination must then be scheduled within two weeks after submitting the revised document. If the student again fails to satisfy his/her Graduate Advisory Committee and external referee(s), a doctoral student, depending on coursework taken, and evaluation and recommendation by the Graduate

Advisory Committee and external referee(s), may be given a terminal Master's degree and dismissed from the program.

- The student may fail altogether. The Graduate Advisory Committee and external referee(s) must then undergo careful, thoughtful, and objective deliberation to decide whether to grant the student another opportunity or to dismiss him/her from the program.

If a student is to be dismissed from his/her graduate program, the decision must be immediately communicated to the Assistant/Associate Dean for Research and Graduate Studies in the form of a memorandum. The Assistant/Associate Dean for Research and Graduate Studies will deliberate with the Deans of SCMNS and SGS and send a formal letter of dismissal from the program to the student.

Preparation of Thesis/Dissertation

A thesis or dissertation must be a high quality professional document that reflects scholarly and original research. It must have the following elements:

- Review and critical analysis of the relevant scholarly literature pertaining to the area of study.
- Clear statement(s) of the purpose of the research or a testable hypothesis.
- Detailed description of the research methodology used so that those reading the document can readily replicate the experimental process. To be included are descriptions of how the data were analyzed by statistics or other tools.
- Presentation of results in a logical, lucid, and consistent style. Graphs and/or tables should not be crowded with data, and they must be interpretable by persons knowledgeable in the area of study.
- Discussion of the data and results in the context of the current and prior research literature. Reasonable conclusion(s) must be derived from the student's research.
- A bibliography of which a style is selected that reflects standards of the area of study. Every citation in the document must be found in the bibliography. Further, each referenced scientific research or review paper, articles from the popular press, Internet web-sites, and all other information sources must be consistent in its format. It is strongly encouraged that students employ software to manage references. For example, End-Note is affordable and easy to use: <http://www.endnote.com>.

The graduate student will assume the primary responsibility that the thesis/dissertation conforms to the requirements and timelines of the SCMNS and SGS. Without exception, the thesis or dissertation is to be constructed with proper grammar and spelling. Use of the first person (i.e., "I") is strongly discouraged and contractions (e.g., can't) are not permitted. There are to be no run-on and incomplete sentences. As an aid to proper writing, the graduate student is referred to Strunk and White's manual, "The Elements of Style"

<http://www.amazon.com/Elements-Style-Fourth-William-Strunk/dp/020530902X>

Nothing within the document should raise questions about the authenticity of the data or results. It is also expected that there will be proper attribution and citation of the words or works of other scholars. Failure to do so may lead to concerns of plagiarism or academic dishonesty, both highly serious offenses.

Moreover, the thesis/dissertation must conform to every formatting requirement of the SGS. The graduate student, Research Advisor, Graduate Advisory Committee members, and the Graduate Program Coordinator must be knowledgeable about these requirements as stated in the *Dissertation &*

Thesis Handbook of the SGS. This can be downloaded at <http://www.morgan.edu/academics/Grad-Studies/pdf/DissThesisHand.pdf>

Accepting the role as Research Advisor means that he/she is willing to provide continuous and meaningful guidance throughout the tenure of the graduate student. This includes proactive and meticulous but fair editing of the thesis/dissertation. Members of the Graduate Advisory Committee are also expected to provide objective and high standards of editorial feedback during the writing of the thesis/dissertation.

In the end, the document must be prepared in such a way that it meets editorial and peer-review standards of a high-impact or highly respected professional scientific journal in the student's area of concentration. It should be "publication-ready," and the student must proceed on the basis that there will be zero tolerance for errors, however minor.

The dissertation in its final form must be approved by all members of the Graduate Advisory Committee, the Graduate Coordinator, and departmental Chairperson, the Assistant/Associate Dean for Research and Graduate Studies, and Dean of SCMNS. The Assistant/Associate Dean for Research and Graduate Studies will ensure quality control of this process and reserves the right to not accept a thesis/dissertation for non-conformance to these stated requirements. The defense of the thesis/dissertation CANNOT proceed until the Assistant/Associate Dean for Research and Graduate Studies and Dean of SCMNS are satisfied that all measures and criteria of quality and scholarship have been met.

During the time the graduate student is writing the thesis or dissertation, continuous enrollment in XXXX 997 (Dissertation Guidance, 3 credits from SCMNS Departments only) is required. Also, a well-advertised public seminar must be given during the final semester of the graduate student's tenure. For this, the student must be enrolled in Dissertation Seminar (XXXX 998).

There are two forms to be used for this process: Dissertation Approval and Request to Schedule Defense of Dissertation.

Oral Defense of Dissertation

The final milestone during the tenure of a graduate student is a public seminar based on his/her research, followed by a closed-door oral defense of the dissertation by members of the Graduate Advisory Committee.

There is a prescribed sequence of events that must be strictly followed before the oral defense is officially permitted.

First, the Graduate Advisory Committee must unanimously endorse the acceptance of the dissertation to be one of high quality, and that it meets all the required criteria of the SCMNS and SGS. Acceptance of the dissertation by the Graduate Advisory Committee is signified by each Committee member signing the Dissertation Approval form.

Second, before the oral defense can be scheduled, the dissertation must be approved by the Assistant/Associate Dean for Research and Graduate Studies and the Dean of SCMNS. The purpose of this procedure is not to question the scientific content of the research embodied in the thesis or dissertation, but rather to make certain that it meets the standards of high quality and scholarship required by

the Office of the Dean, SCMNS. Unless the Assistant/Associate Dean for Research and Graduate Studies and the Dean of SCMNS approve of the dissertation, the oral defense of same cannot be scheduled. There will be no exceptions to this policy.

Third, following approval of the Assistant/Associate Dean for Research and Graduate Studies and Dean of SCMNS, the graduate student will complete the form, Request to Schedule Defense of Thesis or Dissertation. Because of prescribed timelines, especially mandated by the SGS, it is imperative that the graduate student and his/her Graduate Advisory Committee be cognizant of the critical dates by which time certain final milestones must be completed. As already stated above, in recognizing that the oral defense is one of the final steps in the graduate education of the student, this important event requires the approval of the Assistant/Associate Dean for Research and Graduate Studies and the Dean of SCMNS, and there is an especially stringent demand on quality and scholarship. The administration of the SCMNS absolutely reserves the right to delay the oral defense until all matters of quality and strict adherence to policies and procedures have been satisfactorily met.

If the student passes the oral defense, the form Documentation of the Results of Dissertation Defense is completed. Should a student fail the oral defense, the Graduate Advisory Committee must provide in writing on the above-mentioned form reason(s) for their decision. Further, specific guidelines are to be given to the student to assist him/her in a second oral defense. Repeating the defense must be within thirty (30) days of the first defense date, but keeping in mind the deadlines of the SGS. A public seminar is not required for the repeat defense.

Finally, the graduate student will take all appropriate forms, together with the completed (and corrected) dissertation to the SGS. Once there, additional forms are required for the student to fill out.

Graduate Student Responsibilities after Completing Degree Requirements

An important task remains after the graduate student has completed all degree and program requirements, up to and including successful defense of the dissertation and personally submitting the document to the School of Graduate Studies with all pertinent and signed paperwork. The student must, without exception, return to his/her Research Advisor the following:

- Any supplies, software, or equipment that was on loan to conduct research. Such materials are the property of the State of Maryland and must therefore be promptly returned.
- Original forms of data, both written and electronic. These would include bound notebooks, loose paper, photographs, and all forms of digital data storage, including CD-ROMS, DVDs, and USB memory modules. The student has the additional responsibility of properly coding or identifying the data and information so that the Research Advisor or any graduate student can readily trace and follow the records.
- Biological constructs such as recombinant DNA, bacterial plasmids, viral genomes, yeast artificial chromosomes; transformed, transfected, or transgenic cell line(s) or whole organism(s); gene knock-in or gene knock-out cell line(s) or whole organism(s); cell line(s) established from primary cultures.
- Software, hardware, or intellectual property developed while a graduate student.
- All MSU keys and access codes or passwords to secure data files.
- Erasure or destruction of data records from computer internal and/or external hard drives, floppy disks, CD-ROMS and DVDs, USB memory modules, and any other means of electronic data storage are forbidden.

Failure to comply with any of these requirements is a serious matter that may result in Morgan State University reserving the right to withhold granting of the graduate degree.

Checklist for the Completion of Doctoral Degree

The following are steps doctoral students must take in preparation for submitting the dissertation and graduating.

- _____ Submit Application for graduation (October deadline for May graduation) and pay a \$75.00 graduation fee.
- _____ Register for Dissertation Guidance
- _____ Review transcript for missing grades and incorrect grades.
- _____ Work with Graduate Program Coordinator to correct grades.
- _____ Schedule a committee meeting to gain agreement of committee that the dissertation research is completed
- _____ Work with the Dissertation Advisor and committee members to finalize the content of the dissertation.
- _____ Schedule the dissertation defense in cooperation with the committee and Graduate Program Coordinator.
- _____ After the dissertation defense, make all revisions required by the dissertation committee. Prepare final copies of dissertation on required paper.
- _____ Obtain approval and signatures of committee, Graduate Program Coordinator on final dissertation.
- _____ Obtain approval and signature of Associate/Assistant Dean for Research and Graduate Studies and Dean of SCMNS.
- _____ Submit dissertation to School of Graduate Studies.
- _____ Dissertation Fee of \$65.00 and Binding fee of 45.00 (per copy).
- _____ Payment of all financial obligations.

Factors That Contribute To Delays in Graduating

Procrastination is part of human nature. It should therefore come as no surprise when a graduate student waits until critical deadlines to complete a milestone event. This can have serious consequences for the student if problems arise.

Two important dates are the deadlines by which all documentation must be received by the School of Graduate Studies to clear the student for May or December graduation. If, for example, the student schedules the oral defense of the dissertation only one day before the SGS deadline and fails the defense, it will not be possible to meet the desired graduation date.

Although this is but one example of how graduation may be delayed, the student, his/her Graduate Advisor, the Graduate Advisory Committee, and the Graduate Program Coordinator must be aware of critical milestones and dates. In the above scenario, the oral defense must be re-scheduled and the student must unconditionally pass. This should occur within 30 days from the initial oral defense date. The student must then formally reapply for the next graduation date (i.e., May or December), and register for XXXX998, Dissertation Guidance, during the semester of the new graduation date.

SUMMARY OF PROCEDURES FOR DOCTORAL DEGREE

PROCEDURES	UNDER THE DIRECTION OF	DATE
Admission as a potential degree candidate	School of Graduate Studies and Major Department	Prior to completing 15 hours of graduate courses
Appointment of Doctoral Committee*	The School of Graduate Studies on recommendation of Department Chair	Preferable during first year of graduate study, but at the latest, prior to application for admission to candidacy
Comprehensive Examinations*	Major Department	Prior to admission to candidacy
Language Requirement(s)**	Major Department	Prior to admission to candidacy
Submission and approval of application for admission to candidacy	Doctoral Degree Committee and the School of Graduate Studies	At least one semester prior to graduation
Submission of application for graduation	School of Graduate Studies	According to the School of Graduate Studies Academic Calendar
Payment of graduate fees	Bursar's Office	According to the School of Graduate Studies Academic Calendar
Submission of dissertation to the Doctoral Committee	Student	At least two weeks prior to the Defense of Dissertation Examination
Scheduling of Defense of Dissertation Examination	Student, Committee and Office of Graduate Admissions and Records	No later than three (3) weeks prior to Defense of Dissertation Examination
Defense of Dissertation Examination	Doctoral Committee	Scheduled in conjunction with the School of Graduate Studies Academic Calendar
Approval and Acceptance of final copy of Dissertation and Doctoral Forms	Doctoral Committee and the School of Graduate Studies	According to the School of Graduate Studies Academic Calendar
Removal of incomplete(s)	Instructor of the course	Not later than three (3) weeks prior to Commencement

DOCTOR OF PHILOSOPHY—INDUSTRIAL AND COMPUTATIONAL MATHEMATICS (Ph.D.)

Asamoah Nkwanta, Ph. D.

Interim Chairperson

Department of Mathematics

Carnegie Hall, Room 251

Tel: (443) 885-3964; Fax: (443) 885-8216

E-mail Asamoah.Nkwanta@morgan.edu

Objective

The objective of the department's Ph.D. Program is to produce graduates who are broadly educated in the mathematical sciences and who can work at the current research frontiers of their specialized disciplines, including application of such disciplines to solve problems arising in academia, industry, or government.

The Ph.D. program in Industrial and Computational Mathematics (ICM) offers opportunities for candidates to have an in depth study in a field from any one of several branches of mathematics. A student admitted to the program will be able to choose his/her field of study in consultation with an academic advisor who is a member of the faculty. The Department of Mathematics has faculty members with expertise in real analysis, complex analysis, functional analysis, algebra, combinatorics, differential equations and applications, operations research, numerical analysis, topology, mathematical modeling, mathematical biology, and statistics and biostatistics. The underlying principle of the ICM doctoral program is the fact that solving a problem involving applications requires an in depth understanding of the mathematical concepts that are to be applied to real world industrial and computational problems.

The Ph.D. program in Industrial and Computational Mathematics at Morgan State University will offer a broad spectrum of applicable mathematics. A strong background in mathematics is required for admission to this program. Doctoral students will engage in advanced study and dissertation research. Particular emphasis is given to the following areas:

- Analysis and Applications
- Topology and Applications
- Applied Analysis
- Number Theory
- Graph Theory
- Numerical Analysis
- Control Theory
- Operations Research
- Linear and nonlinear programming
- Combinatorics
- Mathematical Modeling
- Nonlinear Evolution Equations
- Algorithms and Computations
- Mathematical Biology

Admissions Criteria

A student should have a Bachelor's degree or an equivalent degree in mathematics from an accredited institution, with a GPA of at least 3.0. A student should have completed courses covering topics in analysis, abstract algebra and topology. In some circumstances, a conditional admission may be given to applicants whose mathematical training is not sufficiently advanced. Previous education in an application area, such as computer science, economics, physics, biology or one of the engineering disciplines, and a basic competence in computational techniques will be favorably considered in a student's application, although this is not a prerequisite. Admission/Application procedure to the Graduate Program in Mathematics will be according to the rules and regulations specified in the document for admission to the School of Graduate Studies. The rules for Visa requirements and for English Language Proficiency for foreign students also will be guided by the rules for admission to the School of Graduate Studies at MSU.

General Requirements:

- All candidates for the Doctor of Philosophy degree in Industrial and Computational Mathematics must complete the required program of courses, seminars and research described in this catalog.
- All candidates must pass the comprehensive written examination and the qualifying oral examination.
- All candidates must submit a doctoral dissertation. When the dissertation has been completed to the satisfaction of the candidate's faculty dissertation advisor and a committee, a dissertation defense will be scheduled, at which time the student must orally defend his or her work before an appointed Doctoral Examination Committee, pursuant to the rules and regulations of such activities.
- All requirements for the doctoral degree in Industrial and Computational Mathematics must be completed within a period of seven consecutive years from the date of admission.
- All candidates must satisfy residency requirements.
- All candidates must maintain a minimum grade point average of 3.0 throughout the program.
- A candidate must demonstrate a competent reading knowledge of significant mathematical material in one foreign language.

Residency Requirements

Award of the degree is consistent upon completion of 72 credit hours of work inclusive of the Dissertation. Students with master's degrees can transfer appropriate credits towards the requirements. The policy of transfer credit is defined by the Transfer Credit Policy of the School of Graduate Studies, Morgan State University.

All candidates must satisfy 18 credit hours of residency requirements in one of the following ways:

- Full-time candidates for the Ph.D. Degree in Industrial and Computational Mathematics must satisfy residency requirements by enrolling in nine (9) credit hours per semester, for two (2) consecutive semesters.
- Part-time candidates for the Ph.D. Degree in Industrial and Computational Mathematics must satisfy residency requirements by enrolling in six (6) credit hours per semester, for three (3) consecutive semesters.

- Upon completion of course requirements and all required examinations, the candidate must continue to register for Dissertation Guidance each semester until the dissertation is successfully completed.

Program of Study

The program of study for doctoral students is prescribed on an individual basis, usually under the direction of a faculty dissertation advisor. The objective of the program of study is to prepare the student for the production of a doctoral dissertation that contains original results in mathematics. The student's undergraduate degree concentration, Master's degree concentration, and interests are taken into consideration in creating a program of study. However, all candidates must successfully complete the following core courses.

Core Courses for the Ph. D. Program in Industrial and Computational Mathematics

	Courses	Description	Length	Credits
	MATH 505, 506	Abstract Algebra	(Two Semesters)	6
	MATH 521, 522	Real Analysis	(Two Semesters)	6
	MATH 527, 528	Complex Analysis	(Two Semesters)	6
	MATH 541, 542	Topology	(Two Semesters)	6
			Total	24

Also, 12 credits of electives will be required. Upon successful completion of the comprehensive written examination, a student must have completed one year (two semesters) of specialized work beyond the comprehensive examination materials before scheduling the oral examination.

Course List

Core Courses	Credits
MATH 505: Abstract Algebra I	3
MATH 506: Abstract Algebra II	3
MATH 521: Real Analysis I	3
MATH 522: Real Analysis II	3
MATH 527: Complex Analysis I	3
MATH 528: Complex Analysis II	3
MATH 541: Point Set Topology I	3
MATH 542: Point Set Topology II	3
Mathematics Electives	Credits
MATH 501: Set Theory and Related Topics	3
MATH 507: Ordinary Differential Equations	3
MATH 508: Combinatorics I	3
MATH 510: Applied Combinatorics and Graph Theory	3

MATH 512: Probability and Statistics	3
MATH 517: Foundations of Geometry	3
MATH 518: Modern Geometry	3
MATH 523: Measure Theory	3
MATH 525: Theory of Numbers	3
MATH 551: Algorithms and Computations I	3
MATH 552: Algorithms and Computations II	3
MATH 553: Computational Mathematics	3
MATH 555: Introduction to Functional Analysis	3
MATH 557: Foundation of Harmonic Analysis	3
MATH 559: Numerical Analysis	3
MATH 561: Mathematical Modeling	3
MATH 575: Introduction to Partial Differential Equations	3
MATH 631: Biostatistics	3
MATH 632: Advanced Biostatistics	3
MATH 633: Applied Regression and Correlation Analysis	3
MATH 635: Computational Linear Algebra	3
MATH 640: Analysis in Several Complex Variables	3
MATH 643: Introduction to Algebraic Topology	3
MATH 645: Distribution Theory and Fourier Analysis	3
MATH 655: Differential Geometry	3
MATH 657: Finite Elements Analysis	3
MATH 662: Pseudo-Differential Operators	3
MATH 663: Nonlinear Programming	3
MATH 664: Abstract Differential Equations	3
MATH 666: Lie Algebras	3
MATH 670: Combinatorial Optimization and Integer Programming	3
Research Seminars	Credits
MATH 665: Introduction to Research In Mathematics Seminar	3
MATH 671: Topics in Applied Mathematics Seminar	3
MATH 673: Topics in Computational Mathematics Seminar	3
MATH 675: Topics in Analysis Seminar	3
MATH 677: Topics in Topology Seminar	3
MATH 679: Topics in Algebra Seminar	3
MATH 788-789: Supervised Research	3
MATH 797: Thesis Guidance	2
MATH 799: Thesis Seminar	3
MATH 848-849: Dissertation Research	3
MATH 899: Dissertation Seminar	3

Examination Requirements for the Ph.D. Degree Program in Industrial and Computational Mathematics

The Mathematics Ph.D. Program examination procedure will have four components:

- I. The written (comprehensive) examination
- II. The oral examination (qualifying)
- III. Language examination
- IV. The dissertation defense

The Comprehensive Written Examination

Students in the Morgan State University Ph.D. Program in Industrial and Computational Mathematics are expected to take the comprehensive examinations after completing the core courses of the program (in approximately four semesters and no later than six semesters after entering the program). The written examinations will be given in the following fields: algebra, real analysis, complex analysis, and topology. The number of subjects in which a student is required to pass the comprehensive exam will be as indicated in the Mathematics Departmental Graduate Catalogue. A student will be allowed two attempts to pass the comprehensive examinations. Failure to pass the comprehensive examinations will result in dismissal from the Ph.D. Program.

The (Qualifying) Oral Examination

Upon successful completion of the written, comprehensive examination, a student will select a dissertation advisor and will begin advanced study under close supervision of the faculty advisor. Also, a student must have completed one year (two semesters) of specialized work beyond the comprehensive examination materials before scheduling the oral examination. A Ph.D. Qualifying Oral Examination Committee of at least four members will be selected by the candidate and his/her faculty dissertation advisor. At least two members, besides the student's faculty dissertation advisor, must be from the graduate faculty. One committee member must be from outside MSU. Additional members, knowledgeable in the area of intended research, may be included in the committee. The student, the faculty dissertation advisor, and the Graduate Program Director will agree on the scope and form of the Ph.D. qualifying oral examination to be administered by the committee (for example, the oral examination might partly take the form of a seminar presentation). The committee must be notified, at least two weeks in advance, of the date, time and place of the Ph.D. qualifying oral examination.

The primary purpose of this examination is to evaluate the student's potential and preparedness for dissertation research. The passing of the oral examination is required before a student can be admitted to candidacy. A student will be allowed two attempts to pass the (qualifying) oral examination. Failure to pass the oral examination is grounds for dismissal.

Language Examination

A candidate must demonstrate proficiency in reading of mathematical literature written in a foreign language where, by a foreign language is meant a language other than English. Such a language must be one which is common in the literature of mathematics. Examples are: French, German, Russian, Chinese, Japanese, or any other language considered suitable for the purpose by the Mathematics Department.

Methods of satisfying the foreign language requirement include:

- passing a language examination prepared by the Mathematics Department in collaboration with the Foreign Languages Department or,
- obtaining at least 9 semester credits in the particular language in courses offered at an accredited institution.

The Dissertation Defense

Upon successful completion of the qualifying oral examination, a student will apply for candidacy and will begin dissertation research. Another requirement for candidacy admission is the completion of the core courses. After completing the doctoral dissertation, a student must successfully defend his/her

dissertation in front of a committee consisting of the faculty dissertation advisor and no less than three additional members, one of whom must be from outside MSU. The dissertation must contain original, publishable results in mathematics.

Admission to Candidacy

Before petitioning for admission to candidacy, a student must have:

- Completed half of the residence requirements.
- Maintained a minimum grade point average of 3.0 in formal course work.
- Passed the qualifying oral examination.
- Obtained the consent of a faculty member who will accept the responsibility of directing a dissertation.

After fulfilling these requirements, the student should complete the Admission to Candidacy form available in the office of the Graduate School and submit the completed form to the Mathematics Department. The department will retain a copy and the form will be forwarded to the Graduate School. Offices of the Dean of School of Computer, Mathematical and Natural Sciences (SCMNS) and the Dean of Graduate Studies could change the procedural matters involving the defense and submission of the Ph.D. dissertation, from time to time as appropriate.

Dissertation (Expected Student Learning Outcome)

Each student entering the Ph.D. program must produce a Ph.D. Dissertation in mathematics to be successful. The Ph.D. Dissertation must represent an original contribution to existing mathematical knowledge. It must follow the format given in the *Handbook for Dissertations and Theses* written by the Graduate School of MSU and available in the Office of Graduate Studies or online. After a successful dissertation defense, copies of the dissertation must be submitted to University offices and units as specified by the Handbook. It is expected that the dissertation or some modification thereof will be submitted to a mathematical journal for publication.

MASTER OF ARTS—MATHEMATICS (M.A.)

Asamoah Nkwanta, Ph.D.

Interim Chairperson

Department of Mathematics

Carnegie Hall, Room 251

Tel: (443) 885-3964; Fax: (443) 885-8216

E-mail: Asamoah.Nkwanta@morgan.edu

Program Objective

The Master of Arts degree in Mathematics is designed for qualified students who contemplate pursuing graduate work beyond the master degree and for qualified secondary school teachers who wish to improve their subject matter competence by earning a master's degree in Mathematics.

General Requirements

Candidates for the Master of Arts degree in Mathematics must complete a minimum of thirty (30) credit hours and submit an acceptable thesis. All candidates must pass a written comprehensive examination. This examination will deal more with comprehension of ideas and concepts than with taking inventory of manipulative skills.

PROGRAM OF STUDY IN MATHEMATICS

Required Courses (18 hours)	Credits
MATH 505-506: Abstract Algebra I, II	6
MATH 521-522: Real Analysis I, II	6
MATH 541: Point Set Topology I	3
MATH 799: Thesis Seminar	3
Total Credit Hours	18
Elective Courses (12)	
MATH 501: Set Theory and Related Topics	3
MATH 507: Ordinary Differential Equations	3
MATH 512: Probability and Statistics	3
MATH 514: Applied Combinatorics and Graph Theory	3
MATH 517: Foundation of Geometry	3
MATH 518: Modern Geometry	3
MATH 523: Measure Theory	3
MATH 525: Theory of Numbers	3
MATH 527: Complex Analysis	3
MATH 542: Point Set Topology II	3
MATH 551, 552: Algorithms and Computations I,II	6
MATH 553: Computational Mathematics	3
MATH 555: Introduction to Functional Analysis	3
MATH 557: Foundation of Harmonic Analysis	3
MATH 559: Numerical Analysis	3
MATH 561: Mathematical Modeling	3
MATH 575: Introduction to Partial Differential Equations	3

MATH 631: Biostatistics	3
MATH 632: Advanced Biostatistics	3
MATH 633: Applied Regression and Correlation Analysis	3
MATH 778, 779: Supervised Research	6
MATH 797: Thesis Guidance 2	3

MASTER OF SCIENCE IN PHYSICS (M.Sc.)

Dereje Seifu, Ph.D.

Interim Chair of Physics
 Dixon Science Research Center, Room 106
 Calloway G22
 Tel: (443) 885-4560; Fax: (443) 885-8288
 Email: Dereje.Seifu@morgan.edu

Objective

The Physics Department at Morgan State University offers the Master of Science degree in Science-Physics for students interested in pursuing professional careers and advanced graduate work in physics and its allied fields. The objective of this program is to produce well-grounded graduates in the advanced concepts and techniques in physics. The graduate will be expected to make a positive contribution to the overall knowledge in physics. To this end, a course of study for students in this program is individually planned coupled with carefully directed laboratory or theoretical research programs. It requires physics elective courses and a research thesis based upon individual laboratory in the field of physics and materials sciences.

Admission Requirement

The candidates for admission into this program are also expected to be graduates of physics from an accredited institution with a GPA of 3.0 or better. Students with an undergraduate degree in mathematics, engineering or other science fields may be admitted on a probationary status. They would be expected to take and pass recommended courses to remedy their deficiencies.

General Requirements

All candidates must pass a written departmental comprehensive examination in their specific area of concentration. Candidates in this program shall be required to complete a total of 30 credit hours as follows: 15 credit hours of courses, 13 credit hours of research and 2 credit hours of seminar. The required courses are as follows:

Courses	Credits
PHYS 500: Mathematical Physics	3
PHYS 511: Classical Mechanics	3
PHYS 528: Quantum Mechanics I	3
PHYS 529: Quantum Mechanics II	3
PHYS 531: Electromagnetic Theory	3
PHYS 788, 789, 791: Supervised Research in Physics	8
PHYS 790: Seminar in Physics	1
PHYS 797: Thesis Guidance	2
PHYS 799: Thesis Guidance	3
Additional courses from specialty area	3
<i>Other Suggested Courses in Physics Include:</i>	
EASC 521: Earth Science	3
EASC 524: Planetary Science	3

PHYS 523: Nuclear Physics	3
PHYS 524: Elementary Particles Physics & Relativity	3
PHYS 525: Computational Physics	3
PHYS 526: Biophysics	3
PHYS 527: Acoustics	3
PHYS 530: Solid State Physics	3
PHYS 535: Materials Physics	3

CONCENTRATION I – Condensed Matter Physics

First Year

First Semester

PHYS 500: Math Physics	3
PHYS 528: Quantum Mechanics I	3
PHYS 790: Seminar in Physics	1
	7

Second Semester

PHYS 531: Electromagnetic Theory	3
PHYS 530: Solid State Physics	3
PHYS 791: Seminar in Physics	1
	7

Second Year

First Semester

PHYS 535: Material Physics	3
PHYS 788: Research	4
PHYS 797:	2
	9

Second Semester

PHYS 789: Research	3
PHYSS 799	4
	7

CONCENTRATION 2 – Elementary Particle Physics / Nuclear Physics

First Year

First Semester

PHYS 500: Math Physics	3
PHYS 528: Quantum Mechanics I	3
PHYS 790: Seminar in Physics	1
	7

Second Semester

PHYS 531: Electromagnetic Theory	3
PHYS 524: Elementary Particle Physics	3
PHYS 791: Seminar in Physics	1
	7

Second Year

First Semester

PHYS 523: Nuclear Physics	3
PHYS 788: Research	4
PHYS 797	2
	9

Second Semester

PHYS 789: Research	4
PHYS 799	3
	7

CONCENTRATION 3 – Earth and Planetary Science

First Year

First Semester

PHYS 528: Quantum Mechanics I	3
PHYS 511: Classical Mechanics	3
PHYS 790: Seminar in Physics	1
	7

Second Semester

PHYS 531: Electromagnetic Theory	3
EASC 521: Earth Science	3
PHYS 791: Seminar in Physics	1
	7

Second Year

First Semester

EASC 524: Planetary 3

Science

PHYS 788: Research 4

PHYS 797 2

9

Second Semester

PHYS 789: Research 4

PHYS 799 3

4

7

MASTER OF SCIENCE – BIOINFORMATICS (M.S.)

William Lupton, Ph.D.

Chairperson, Associate Professor
 Calloway Hall Room 205
 Tel: 443-885-4503
 E-mail: William.Lupton@Morgan.edu

Vojislav Stojkovic, Ph.D.

Program Coordinator, Associate Professor
 Calloway Hall Room 306
 Tel: 443-885-1054
 E-mail: Vojislav.Stojkovic@Morgan.edu

Program Objective

The Master of Science in Bioinformatics degree program is a multidisciplinary degree program. It involves the required courses from Bioinformatics, Computer Science, Mathematics, and Statistics and the elective courses from Bioinformatics, Computer Science, Mathematics, Statistics, Science, Health, Engineering, or Business. Bioinformatics integrates computer, mathematical, statistical, biological, chemical, physical, and etc methods to solve problems in bioinformatics. The program is designed to offer students the broad-based interdisciplinary research training necessary for professional work in industry and continued post-graduate training in the field.

Admission Requirements

The candidates for admission to the program are expected to be graduates of Bioinformatics, Computer Science, Mathematics, Statistics, Science, Health, Engineering or Business with a GPA of at least 3.0. Students admitted to the program are required to take and pass recommended courses to remedy any deficiency in a discipline that serves as a foundation for the study of bioinformatics.

General Requirements

The required curriculum for completion of the program consists of a total of 36 credits, comprehensive examinations, and thesis.

15 credit hours will be taken of the Bioinformatics Core Courses, 12 credit hours of the Scientific Core Courses, 6 credit hours of the Common Elective Courses, and 3 credit hours Thesis Seminar in Bioinformatics course.

Students who have not completed their thesis in the Fourth Semester - to continue their study-research have to take under the Thesis Mentor supervision 2 credit hours Thesis Guidance in Bioinformatics course.

Bioinformatics Core Courses

BIOI 511: Bioinformatics I	3
BIOI 512: Bioinformatics II	3

BIOI 513: Bioinformatics III	3
BIOI 521: Bioinformatics Tools and Databases	3
BIOI 591: Current Topics in Bioinformatics	3
	15
Scientific Core Courses	
BIOI 531: Bioprogramming	3
COSC 541: Scientific Visualization	3
MATH 631: Biostatistics	3
MATH 553: Computational Mathematics	3
	12
Common Elective Courses	
BIOI 522: Bioalgorithms	3
BIOI 542: Biovisualization	3
BIOI 561: Modeling and Simulation in Bioinformatics	3
COSC 521: Algorithms	3
COCC 571: Software Agents	3
COSC 572: Genetic Algorithms and Programming	3
MATH 514: Applied Combinatorics and Graph Theory	3
MATH 561: Mathematical Modeling	3
MATH 632: Advanced Biostatistics	3
BIOL 520: Biochemistry	3
BIOL 545: Computational Molecular Biology	3
BIOL 571: Genetics	3
CHEM 547: Computational Chemistry	3
CHEM 573: Protein and Amino Acids	3
PHYS 525B: Computational Physics for Bioinformatics	3
PHYS 526: Biophysics	3
Thesis Seminar Course	
BIOI 799: Thesis Seminar in Bioinformatics	3
Thesis Guidance Course	
BIOI 797: Thesis Guidance in Bioinformatics	2

The cross-disciplinary nature of the curriculum offers great flexibility to graduate students toward their degree based on their personal scientific interests and background.

First Year

First Semester

BIOI 511 Bioinformatics I	3
BIOI 521 Bioinformatics Tools and Databases	3
BIOI 531 Bioprogramming	3
	9

Second Semester

BIOI 512 Bioinformatics II	3
COSC 541 Scientific Visualization	3
MATH 631 Biostatistics	3
	9

Second Year**First Semester**

BIOI 513 Bioinformatics III	3
MATH 553 Computational Mathematics	3
First Elective Course	3
	9

Second Semester

BIOI 591	3
Second Elective Course	3
BIOI 799 Thesis Seminar in Bioinformatics	3
	9

Third and further Year(s) – if necessary

Continue in:

BIOI 797 Thesis Guidance in Bioinformatics	2
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Elective Courses

Any Graduate 5xx/6xx course related to the student thesis research for which prerequisites have been completed can be selected as an elective course. The elective course selection should be the result of the student and her/his academic or research advisor mutual agreement.

Comprehensive Examinations

Comprehensive examinations are based on the student's coursework and general background that the student's advisory/thesis committee thinks is necessary to address specifically the proposed area of the thesis research.

The goal of comprehensive examinations is for students to demonstrate his or her general proficiency in bioinformatics.

The aim of comprehensive examinations is to require students to review all prior coursework in the requirement and concentration areas. Comprehensive examinations will also test students' ability to synthesize and interpret information in the critical intellectual fashion expected of M.S. candidates and to judge the aptitude of candidates for carrying out research.

Examination results may be used by the student's advisory/thesis committee, at their discretion, to guide the student's selection of additional requirements/courses to complete the program.

Comprehensive exam is in written form and consists from 8 questions/parts

Bioinformatics - Bioinformatics 1, 2, 3
 BioProgramming
 Tools and Databases
 Mathematics – Computational Mathematics
 Statistics - Biostatistics
 Visualization – Scientific Visualization

Comprehensive examinations are long 4 hours (for each question/part 30 minutes). The questions/parts could be taken in different days/times during 5 working days period.

Comprehensive examinations grades are: pass or fail.

The student must pass comprehensive examinations in maximum of two attempts.

Comprehensive examinations must be taken and completed within three (3) years following initial enrollment in the M.S. Bioinformatics Program.

Thesis

Thesis is a document submitted in support of candidature for the academic degree Master of Science (MS). A thesis in Bioinformatics usually has theoretical, computational, experimental, and application components.

Thesis reports on a research project or study, or an extended analysis of a topic. Thesis explains the purpose, the previous research literature on the topic of the study, the methods used and the findings of the project. A multiple chapter format is recommended:

- a. an introduction, which introduces the research topic, the methodology, as well as its scope and significance;
- b. a literature review, reviewing relevant literature and showing how this has informed the research issue;
- c. a methodology chapter, explaining how the research has been designed and why the research methods
- d. /population/data collection and analysis being used have been chosen;
- e. a findings chapter, outlining the findings of the research itself;
- f. an analysis chapter, analyzing the findings
- g. a discussion chapter, discussing the findings in the context of the literature review and future work
- h. a conclusion

Thesis should be written according the Morgan State University School of Graduate Studies [Handbook and Style Guide for Dissertations and Theses](#). The Handbook includes specific format requirements for the School of Graduate Studies.

Thesis has to be presented to the Thesis Committee and successfully defended at the Thesis Defense open to public.

Thesis defense must be announced to the SCMNS community at least 5 working days in advance.

Satisfactory Progress

A student must make satisfactory progress towards the degree. If the advisory/thesis committee determines that satisfactory progress is not being made, a student may be required to withdraw because of academic deficiency. Students may appeal this decision with the appropriate Morgan State University committee.

MASTER OF SCIENCE IN SCIENCE (CHEMISTRY) (M.S.)

Angela Winstead, Ph.D.

Chairperson, Chemistry

Spencer Hall, Room 318

Tel: (443) 885-3115; Fax: (443) 885-8286

E-mail: angela.winstead@morgan.edu

Program Objective

The Master of Science in Science degree is a Professional Chemistry degree program for students interested in pursuing professional careers and advanced graduate work in chemistry and its allied fields. The objective of this professional track is to produce well-grounded graduates in the advanced concepts and techniques in chemistry. The graduate will be expected to make a positive contribution to the overall chemical knowledge. To this end, a course of study for students in this program is individually planned coupled with carefully directed laboratory or theoretical research programs.

Admission Requirements

All applicants with a bachelor's degree in chemistry and a major GPA of 3.0 or better from an accredited institution are eligible for admission. In some cases, candidates with a GPA of less than 3.0 may be admitted on probationary status. Such candidates would be required to take and pass recommended courses with grades of B or better to remedy their deficiencies. The deficiency remediation must be completed within one academic year. The Department of Chemistry requires all entering graduate students to take proficiency examinations in Analytical, Biochemistry, Inorganic, Organic, and Physical Chemistry. The proficiency exam process is not designed to be punitive. The exams are diagnostic in nature and help the department evaluate each student's undergraduate preparation. Course registration for the fall will be based to some extent on a student's performance on these examinations. It is to a student's advantage to do well on the ACS exams, and review of appropriate material is highly encouraged. Following the completion of proficiency exams, each student will have a meeting with the Graduate Coordinator who will review exam performance and advise the student regarding course selection and registration.

General Requirements

Candidates in this program shall be required to complete a total of 34 credit hours as follows: 21 credit hours of courses (CHEM 531(3), 541(3)/603(3), 551(3), 561(3), 581(3), 797(2), Advised Elective (3), 8 credit hours of research and 5 credit hours of seminar (CHEM 790(2), 799(3)). All candidates are required to submit a written thesis based on their directed research. During the first year, students must select a Thesis Committee, which must consist of the student's major professor plus at least three other faculty members in the field. All candidates must pass an approved written departmental comprehensive examination. This examination must be taken in the first semester following the successful completion of all core course work. The required courses are as follows:

COURSES	CREDITS
CHEM 531: Advanced Analytical Chemistry I	3
CHEM 541/603: Chemical Kinetics/Physical Chemistry	3
CHEM 551: Advanced Organic Chemistry	3
CHEM 561: Advanced Inorganic Chemistry	3

CHEM 581: Advanced Techniques in Chemistry	4
CHEM 788,789: Supervised Research in Chemistry	8
CHEM 790: Graduate Seminar	2
CHEM 797: Thesis Guidance	2
CHEM 799: Thesis Seminar	3
Additional advised course(s) from specialty area	3(4)
TOTAL:	34(35)

MASTER OF SCIENCE IN SCIENCE (BIOLOGY) (M.S.)

Yun-Chi Chen, Ph.D.

Graduate Coordinator of Biology

Key Hall, Room G-51

Tel: (443) 885-4002; Fax: (443) 885-8285

E-mail: yun-chi.chen@morgan.edu

Objective

The Master of Science in Science degree in Biology is intended for students interested in pursuing advanced graduate work in Biology and related fields. The objective of this program is to produce well-grounded graduates in the advanced concepts and techniques in Biology. The program emphasizes a strong background in current areas of biology and biological research. It requires biology core and elective courses and a research thesis based on individual laboratory research. The research component will expand the competency of students in biology and advance their careers as scientists in the field. To this end, the course of study for students in this program is individually planned coupled with carefully directed laboratory or theoretical research programs.

Admission Requirements

Candidates are expected to also have a baccalaureate degree in Biology, or related discipline, from an accredited institution. GRE scores on the GRE General and Subject (Biology) tests are required for admission in good standing and are essential for Teaching Assistant (TA) or fellowship consideration. Evidence of research capability should be included. International students from countries whose primary language of instruction is not English must submit a TOEFL score of at least 550.

General Requirements

Candidates are required to complete a total of 33 credit hours as follows: 23 credit hours of courses, 8 credit hours of research and 2 credit hours of seminar. During the first year, students must select a Thesis Committee, which must consist of the student's major professor plus at least three other faculty members in the field. All candidates must pass an approved written comprehensive examination and submit a written thesis proposal.

PROGRAM OF STUDY

Requirements for Master of Science in Science (Biology)

COURSES	CREDITS
BIOL 520: Biomolecular Structure	3
BIOL 522: Advances In Research Techniques	3
BIOL 523: Seminar Topics in Modern Biology & Environmental Sciences 2x1	2
BIOL 525: Cellular Biology	3
BIOL 526: Molecular Biology	3
BIOL 788-789: Supervised Research in the Area of Specialty	8
BIOL 797: Thesis Guidance	2
BIOL 799: Thesis Seminar	3

Other Suggested Courses in Biology include:

BIOL 521: Bioecology	3
BIOL 524: Advanced Molecular Genetics	3

BIOL 527: Microbiology of Emerging Pathogens	3
BIOL 528: Immunobiology	3
BIOL 532: Toxicology	
BIOL 533: Environmental Toxicology	3
BIOL 536: Molecular & Behavioral Neuroscience	3
BIOL 540: Computational Biology/Bioinformatic	3
BIOL 601: Molecular Biotechnology	3

SCHOOL OF COMPUTER, MATHEMATICAL & NATURAL SCIENCES

COURSE DESCRIPTIONS

DEPARTMENT OF BIOLOGY

BIOL 520: Biomolecular Structure

Three Hours: 3 Credits

Covers topics in protein structure and function, enzyme kinetics and mechanisms of enzyme action, metabolism of carbohydrates, lipids, amino acids and nucleotides, bioenergetics and energy considerations in biochemistry, and analyzes various techniques and instrumentations used in biochemical studies.

BIOL 521: Bioecology

Three Hours: 3 Credits

This course is designed to develop an in-depth understanding of the major principles connected with the interrelationships of organisms and organisms and their environment. The major chemical, physical and biotic factors of the environment will be analyzed for their influence on the distributor and functional processes of plant and animal communities.

BIOL 522: Advances in Research Techniques

Three Hours: 3 Credits

This course provides the first-year graduate student with an intensive hands-on approach to modern techniques and methodologies of biomedical research. Students will be introduced to theories and practices of qualitative and quantitative analysis of proteins, gel electrophoresis, enzyme assays, column chromatography, nucleic acid "blot-and-probe" techniques, differential centrifugation, cell culturing, and radioisotope methodology.

BIOL 523: Seminar Topics in Modern Biology & Environmental Sciences

Two Hours: 2 Credits

This course explores in-depth reviews of modern scientific topics in biology and environmental sciences. It enables students engaged in this course to review the literature and provide discussions on the topics.

BIOL 524: Advance Molecular Genetics

Three Hours: 3 Credits

This is a lecture course designed as a logical extension of the Introductory Genetics and Population Biology courses encountered in the undergraduate curriculum. The relatedness of life forms through the central dogma concept is the fundamental driving force in explaining the how and why of studying simpler organisms as a prelude to an understanding of the more complex systems. This course is therefore designed to continually enhance the knowledge base in the ever-changing field of molecular genetics both as to theory and practice.

BIOL 525: Cellular Biology

Three Hours: 3 Credits

This course is designed to integrate basic concepts of cellular biology with general topics in the areas of biochemistry, genetics and molecular biology. The major topics of discussions will be: structure, function and biogenesis of macromolecules and cellular organelles, cell membrane and the cytoskeleton, mem-

brane transport mechanisms, cell surface and intracellular communication, energy requirements for cellular activities, synthesis and sorting, distribution of specific organellar proteins and their major role in overall cellular function. Taken together, specific topics from these four major disciplines will provide the students with an understanding of how cells function. Also, the major experiments that led to the discovery of some of these important facts in cellular biology will be emphasized.

BIOL 526: Molecular Biology**Three Hours: 3 Credits**

This is lecture course will provide students with the theoretical basis for appreciating and understanding the basic principles and methodologies of modern molecular biology through lectures and discussions of the current scientific literature and textbook assignments on selected topics in molecular biology. The course is designed to integrate basic concepts of molecular biology with fundamental topics in other areas of cellular biology, biochemistry, microbiology, and molecular genetics. Special emphasis will be given to topics covering the following themes: structure and properties of nucleic acids; DNA replication, repair, and recombination; molecular biology of gene expression and its regulation in prokaryotes and eukaryotes; protein structure and translational control; and molecular biotechnology with an emphasis on recombinant DNA technology, protein engineering, vaccines and therapeutics, immunodiagnostics, and genetic engineering of mammalian and plant organisms.

BIOL 527: Microbiology of Emerging Pathogens**Three Hours: 3 Credits**

This is a lecture course that will address the microbiology of emerging pathogens with the hope of understanding the factors involved in disease emergence, prevention, the public health impact, and control. The course will cover selective pathogen topics such as Hantavirus, emerging foodborne pathogens, HIV/AIDS and multidrug resistant tuberculosis among high-risk group's etc. The course will follow instruction and discussion of recent publications on particular topics.

BIOL 528: Immunobiology**Three Hours: 3 Credits**

This course will emphasize the significant new advances in the field of immunology, immunobiology and immunotherapy. This multidisciplinary field of study integrates molecular biology, cell biology and physiology. Students will acquire an in-depth understanding of basic research in immunology that is applicable to the diagnosis and the development of treatments for immunodeficiencies, autoimmune disease, cancer and AIDS. The course will also emphasize new biotechnological strategies for the development of novel vaccines.

BIOL 531: Environmental Science**Three Hours: 3 Credits**

This course is designed to provide students with an in-depth understanding of fundamental scientific principles and concepts necessary for a better understanding of environmental science, environmental problems, causes and solutions. Emphasis is placed on urban environmental problems, issues and solutions together with the impact of man on the environment. Prerequisites: BIOL 521.

BIOL 536: Molecular and Behavioral Neuroscience**Three Hours: 3 Credits**

This course will investigate the fundamental concepts of the nervous system, brain, and behavior by emphasizing the interrelationships between neurobiology and cognitive science. Part of the course will focus on the nervous system structure, function and development and will be used in understanding the

biological basis of learning, memory, and behavior in both normal and altered states. Current research, such as the latest discoveries in the genetics and molecular biology of behavior and the social implications of these discoveries will be used in graduate level discussions and presentations. Critical thinking and analysis of relevant scientific literature will also be emphasized.

BIOL 540: Computational Biology/Bioinformatics**Three Hours: 3 Credits**

The course will facilitate the use of computational tools in studying diverse biological problems including developing population growth and prey models, utilizing statistical models in explaining biological concepts, analyzing fundamental problems of DNA and protein structure and function, performing biological database searches and information retrieval, and providing real time three-dimensional images and high resolution graphics displays.

BIOL 601: Molecular Biotechnology**Six Hours: 4 Credits**

This is predominantly a laboratory course with direct hands-on laboratory experiences using state-of-the-art techniques and experimental approaches in the production of heterologous proteins in prokaryotic and eukaryotic cells utilizing bacterial (prokaryotic) as well as insect, yeast, and mammalian (eukaryotic) expression vectors. Students will use molecular biology approaches, including techniques in recombinant DNA and genetic engineering technology to clone, express, affinity-purify, and characterize the recombinant proteins produced in the prokaryotic and eukaryotic host cells. The theoretical component of the course introduces the student to the fundamental principles, applications, strategies, and societal concerns of *Molecular Biotechnology*, and will facilitate an understanding of important theoretical concepts which will be complemented by the methodologies and experimental strategies covered in the laboratory portion of the course.

BIOL 602: Environmental Immunotoxicology**Three Hours: 3 Credits**

Studies the adverse effects of environmental chemicals and toxins on the immune system. The course will examine the influence of environmental or toxic agents on immune function and the cellular and molecular mechanisms that lead to alterations in the immune response.

BIOL 603: Marine and Aquatic Biology**Four Hours: 4 Credits**

This course examines the broad and multidisciplinary approach to marine and aquatic life and the biological processes in shallow coastal waters and the open ocean. It examines and quantifies organismal physiological response to the abiotic and biotic environment. Aspects of population and community structure, reproduction and larval biological reproduction systems are also examined. Prerequisite: Bioecology, Basic Statistics.

BIOL 604: Ecosystem Analysis**Four Hours: 4 Credits**

This course exposes students to ecosystem-level questions; demonstrates field-data collection and laboratory analysis; emphasizes data manipulation on microcomputers; and introduces professional data presentation techniques (graphing, transparencies, slides, multi-media, etc.). Some student projects are expected to generate large enough data sets to test hypothesis and develop publishable conclusions. Class sessions comprise lecture and field/ laboratory components. Prerequisite: core courses.

BIOL 605: Dynamic Computer Modeling**Three Hours: 3 Credits**

Models are used to synthesize information, identify research gaps, guide experimentation, and explore scenarios not feasible to test in the real world. This course introduces students to effective (computer) modeling tools, and emphasizes using models to develop and guide research. This course is designed to provide students with a clear understanding of available modeling tools that can be used to effectively present, guide, and explore their graduate research projects.

BIOL 606: Environmental Toxicology**Three Hours: 3 Credits**

Covers relevant problems in environmental toxicology, with an emphasis on the nature, distribution and effects of environmental toxicants; exposure and dose-response characterizations, and risk assessment and risk management will be covered.

BIOL 607, Toxicology of Biological Systems (3 credits)

The course addresses the basic concepts of cell-, tissue-, organ-, and system-specific toxicity induced by selected chemicals. Understanding the mechanisms and interactions between toxic agents and targeted systems is essential for studies of biomedical, clinical, forensic, and environmental toxicology. Prerequisite: BIOL 525 or permission.

BIOL 609: Environmental Microbiology**Three Hours: 3 Credits**

Covers current topics in selected areas of environmental microbiology, with an emphasis on the genetics and pathophysiology of microorganisms.

BIOL 610: Molecular Epidemiology of Infectious Diseases**Three Hours: 3 Credits**

Application of molecular typing techniques to study of microbial pathogens to increase understanding of epidemiology of infectious diseases. Evaluation of methods used in outbreaks and epidemics reported in literature. Prerequisite: Advanced Cell & Molecular Biology.

BIOL 611: Food and Water Borne Diseases**Three Hours: 3 Credits**

Study of identification and characteristics of chemicals and biological agents implicated in food and water borne disease outbreaks and conditions or circumstances by which food contamination occurs. Examination of food protection activities conducted by local and state government at the retail level. Principles and requirements of public water supply for protection of public health. Includes essential characteristics of water quality and sources, water treatment and distribution systems with associated health hazards; public health, epidemiology, risk assessment; surveillance, regulatory needs to assure safe public water supplies. Prerequisite: Environmental Sciences.

BIOL 612: Advanced Environmental Health**Three Hours: 3 Credits**

Examines health issues, scientific understanding of causes, and possible future approaches to control of the major environmental health problems in industrialized and developing countries. Topics include how the body reacts to environmental pollutants; physical, chemical, and biological agents of environmental contamination; vectors for dissemination (air, water, soil); solid and hazardous waste; susceptible

populations; biomarkers and risk analysis; the scientific basis for policy decisions; and emerging global environmental health problems.

BIOL 619: Business Concepts for Environmental Managers**Three Hours: 3 Credits**

The course offers environmental managers a basic understanding of accounting systems-to enable them to interpret financial data in corporate and governmental settings, to integrate traditional business concepts with those of sustainable environmental management, and to recognize the role of environmental management among the multiple interests within business negotiations. The first part of the course develops skill in financial accounting, and this knowledge is then applied to areas in environmental financial management, including budgeting, project finance, and business development and strategy.

BIOL 620: Environmental Genetics**Three Hours: 3 Credits**

Studies the effects of exposure to various environmental chemicals and carcinogens on genetic diseases. The course examines the alteration of the genetic make-up of model organisms by environmental chemicals and other carcinogens, and the influence of such environmental factors on the alteration of target gene expression and development of carcinogenesis.

BIOL 624: Environmental Biotechnology**Three Hours: 3 Credits**

The course examines the use of biotechnology techniques and methods for the analysis and solution of environmental problems. Areas of particular interest include the use of novel microorganisms for applications in the removal of pollutants, toxic chemicals, and hazardous wastes from the environment.

BIOL 625: Seminar Topics in Modern Biology and Environmental Sciences**Two Hours: 1 Credit**

Gives an in-depth review of modern topics in the biological and environmental science fields. It enables students to review the research literature and provide discussions on the topics. These seminars emphasize contextual and integrated understanding, analysis and synthesis, conflicts and ethical issues, enhanced communication and teamwork.

BIOL 626: Environmental Physiology of Plants**Three Hours: 3 Credits**

The course examines the regulation of plant growth and development, nutrition, and the effects of environmental stress, chemicals, and pollutants on the physiology and development of crop plants of economic importance.

BIOL 627: Molecular Toxicology of Diseases**Three Hours: 3 Credits**

Advanced discussion of molecular mechanisms whereby chemical, physical, and biological agents produce harmful effects on biological tissues. Prerequisite: Advanced Cell and Molecular Biology.

BIOL 628: Environmental Carcinogenesis**Three Hours: 3 Credits**

Biochemical and molecular basis of carcinogenesis induced by chemical and physical agents in the environment, including detailed discussion of multi-stage process of carcinogenesis, mechanisms of

action of specific chemical and physical carcinogens; current approaches to identification of carcinogens, and chemoprevention strategies.

BIOL 629: Developmental Neurotoxicology**Three Hours: 3 Credits**

This course will introduce students to the full spectrum of environmental effects on the developing nervous system. This includes pre-and postnatal effects of toxicants on the developing nervous system along with the discussion of physical, psychological and sociological constraints of nervous system development. Special emphasis will be given to effects on the development of the mammalian Central Nervous System [CNS], however, Peripheral Nervous System [PNS] effects and other vertebrate models will be discussed where and when relevant.

BIOL 630: A Seminar I: Global Environment and Public Health**Two Hours: 1 Credit**

Explores the impact of development and industrialization on the global environment, such as disease transmission, desertification, deforestation, collapse of marine fisheries, declining agricultural production, and biodiversity loss. Provides an overview of scientific and policy issues surrounding global environmental health issues.

BIOL 630B: Seminar II: Reproductive and Developmental Toxicology**Two Hours: 1 Credit**

Investigates chemicals that can induce adverse reproductive and developmental outcomes. Discussion topics include identification and characterization of specific classes of toxic agents, mechanisms of action of these agents at the molecular and cellular level, and risk assessment and regulatory issues. Prerequisite: Advanced Cell and Molecular Biology.

BIOL 630C: Seminar III: Biotechnology, Bioinformatics, and Ecogenetics**Two Hours: 1 Credit**

Methodologies currently used for characterization, storage, and retrieval of genetic information relevant to gene-environment interactions that contribute to diseases of public health importance. Working knowledge of molecular genotyping and phenotyping, genomics, and bioinformatics related to genetic testing provided. Prerequisite: Advanced Cell & Molecular Biology.

BIOL 630D: Seminar IV: Neuroepidemiology and Environmental Risk Factors**Two Hours: 1 Credit**

Focus on neurologic diseases and etiology. Presentation of descriptive epidemiology, clinical features, and risk factors, including stroke, Parkinson's disease, Alzheimer's disease, AIDS, multiple sclerosis, and other disorders. Prerequisite: Advanced Environmental Sciences.

BIOL 631: Bioethics and Communications**Three Hours: 3 Credits**

Students in this course analyze, discuss and write on traditional philosophical theories regarding the nature of the moral good. They then apply these theories to critical issues and selected cases involving experiments with human subjects, organ transplantation, in vitro fertilization, the use of animals in research, the collection and publication of research data, peer review, conflicts of interest, and other topics of current concern. The course also emphasizes how to write scientific papers for peer-reviewed journals, for in-house scientific progress reports, for lay audiences, and for grant applications. Approaches to making formal oral presentations and posters are also presented. Class discussions center

around writing and speaking skills and the author/speakers' responsibility to present accurate accounts of results, applications, and implications of their research. Students have weekly writing and reading assignments.

BIOL 632: Professional Communication and Research Conduct

Three Hours: 3 Credits

This class will prepare graduate students to be proficient in all major aspects of professional scientific communications. In addition ethical issues connected to the communication of research results and professional conduct will be discussed. Students are expected to complete assignments involving their own research results. This class will be most effective if taken during the students second year in the program, after significant research results have already been obtained.

BIOL 639, Fundamentals of Bioenvironmental Science (3 credits)

This course illuminates various factual and conceptual mechanisms of human relationships with other organisms and physical environment, including the hydrosphere, lithosphere, and atmosphere. Moreover, it incorporates these relationships in terms of organismal and environmental sustainability. It utilizes a trans-disciplinary approach of biology, ecology, geography, physics, geology, chemistry, economics, sociology, agriculture, risk assessment, toxicology, genetics, law, physiology, politics, ethics, and morality.

Prerequisite: BIOL 525 or permission.

BIOL 788-789: Supervised Research

Four Hours: 4 Credits each course

These are research courses designed to enable students to participate in research in the areas of their competence under the supervision of qualified faculty members. Students are required to submit oral presentations of research findings in seminars and to submit a written thesis report to the graduate faculty.

BIOL 797: Thesis Guidance

Two Hours: 2 Credits

BIOL 799: Thesis Seminar

Three Hours: 3 Credits

BIOL or CHEM 800-804 Supervised Doctoral Research

Three Hours: 3 Credits each course

These courses are designed to allow students to participate in doctoral research in areas of their choosing under the supervision of a research mentor and also to defend their thesis for the doctoral degree. Students are required to submit their research findings in a seminar topics series.

BIOL 997: Dissertation Guidance

Three Hours: 3 Credits

BIOL 998: Dissertation Seminar

Six Hours: 6 Credits

DEPARTMENT OF CHEMISTRY**CHEM 531: Advanced Analytical Chemistry I****Three Hours: 3 Credits**

The course covers the principles and methods at advanced level in modern chemical analysis. Topics will include separation techniques, GC, HPLC, Spectrometry, lasers and electrophoresis. Prerequisite: CHEM 314.

CHEM 532: Advanced Analytical Chemistry II**Three Hours: 3 Credits**

Advanced topics in Chemical equilibrium and kinetics in analytical chemistry, thermal and electrochemical methods will also be covered in this course. Prerequisite: CHEM 314.

CHEM 533: Statistical Methods in Analytical Chemistry**Three Hours: 3 Credits**

This course covers a variety of computer-aided models to treat and interpret laboratory experimental data. Topics to be covered include: Errors in measurement, bi and multivariate data analysis, analysis of variation (ANOVA) and ancillary techniques including Monte Carlo simulations. Prerequisite: CHEM 314 or equivalent.

CHEM 534: Advanced Analytical Chemistry III**Three Hours: 3 Credits**

Selected topics in electronics and computer applications in analytical chemistry will be covered. Signal processing, computer-aided analysis, electronic gates in signal processing in analytical chemistry. Prerequisite: CHEM 314.

CHEM 541: Chemical Kinetics**Three Hours: 3 Credits**

This course will cover the fundamental understanding of chemical reaction rates and mechanisms, orders of reaction and their application to biological systems, thermochemical kinetics, catalysis and fast reactions in gases and condensed phases. Prerequisite: CHEM 308.

CHEM 542: Colloids and Surface Chemistry**Three Hours: 3 Credits**

Discussion of colloid materials and their applications, surfaces, interface and reactivity on material surfaces and interphases will be covered. Stability of colloids, rheology, emulsions and foams are topics in the course. Prerequisite: CHEM 308.

CHEM 543: Chemical Thermodynamics**Three Hours: 3 Credits**

Thermodynamics and its applications; solutions and phase equilibria for one and multicomponent systems, equilibrium considerations in thermodynamics. Prerequisite: CHEM 307.

CHEM 544: Molecular Spectroscopy**Three Hours: 3 Credits**

This course deals with chemical structures at the atomic and molecular levels. It uses quantum mechanical principles and the accompanying symmetry and molecular point groups methodology to understand the fundamental basis of the interaction of electromagnetic radiation with matter and the interpretation

of the resulting atomic and molecular spectra and their relationship to chemical reactivity. Prerequisites: CHEM 308 and 407.

CHEM 545: Special Topics in Analytical/Physical Chemistry

Two Hours: 2 Credits

Special topics course in analytical/physical chemistry, which may be taken as an independent course by graduate students with concentration in analytical or physical chemistry. It covers current/frontier areas in analytical or physical chemistry, which may include electrochemistry, separation techniques, quantum mechanical treatment of molecules and structural determination. Prerequisite: Graduate Standing with consent of Instructor.

CHEM 546: Quantum Chemistry

Three Hours: 3 Credits

Rigorous study of the basic tenets of quantum mechanics as applied to chemical systems; variational and perturbation theory, Hartree-Fock and Franck-Condon principle, the electronic structure of atoms and molecules and their energy systems will be covered. Prerequisite: CHEM 308 and CHEM 407.

CHEM 547: Computational Chemistry

Three Hours: 3 Credits

Modern theoretical (classical and quantum) methods used in the study of molecular structure, bonding and reactivity will be covered. Determination of molecular spectra, relationship to experimental techniques and concepts of practical applications will be covered. Prerequisite: CHEM 308, CHEM 407 and COSC 237.

CHEM 551: Advanced Organic Chemistry

Three Hours: 3 Credits

Emphasis will be on the structure, synthesis and bonding in organic compounds, reaction mechanisms (ionic, free radical and concerted). Prerequisite: CHEM 204, 408.

CHEM 552: Organic Synthesis

Three Hours: 3 Credits

This course covers principles of reactions leading to carbon-carbon formation, functional group transformation, protecting groups and masked groups introduction. Strategies of skeletal structures of main classes of biologically interesting compounds will be covered. Prerequisite: CHEM 204, 408.

CHEM 553: Polymer Chemistry

Three Hours: 3 Credits

Principles of structural and physical properties of polymers, copolymers and block copolymers, characterization, degradation and stabilization of polymeric materials will be studied. Prerequisite: CHEM 204, 408.

CHEM 555: Natural Products Chemistry

Three Hours: 3 Credits

This course is designed to provide the students an understanding of structure, classes, biosynthesis, biological significance, and reactions of major classes of natural products such as carbohydrates, terpenoids, fatty acids, amino acids, antibiotics, and alkaloids. Recent synthetic strategies of natural products will be covered.

CHEM 561: Advanced Inorganic Chemistry**Three Hours: 3 Credits**

Principles of chemical bonding in metals and nonmetals, ligand field theory, applications of group theory to chemical bonding, inorganic reaction mechanism. Prerequisite: CHEM 312, 309.

CHEM 562: Organometallic Chemistry**Three Hours: 3 Credits**

The principles and chemistry of compounds containing carbon-metal bonds, their synthesis and reaction mechanisms will be studied. Prerequisite: CHEM 312.

CHEM 563: Bioinorganic Chemistry**Three Hours: 3 Credits**

Structure and bonding of inorganic material with biological systems will be covered. Functional relationship and reactions are additional topics covered. Prerequisite: CHEM 312 and CHEM 204.

CHEM 565: Special Topics in Inorganic/Organic Chemistry or Biochemistry**Two Hours: 2 Credits**

Special topics course in inorganic, organic or biochemistry, which may be taken as an independent course. It covers current/frontier areas in inorganic, organic or biochemistry which may include specific areas in transition metals and non-metal chemistry, application of group theory to reaction mechanisms, trends in stereochemical synthesis, pericyclic reactions, linear free energy relationship in organic chemistry, proteins and their structure-activity relationship, nucleic acid and their interactions with other biomolecules and their relationship to biomedical technology. Prerequisite: Graduate standing with consent of Instructor.

CHEM 571: Advanced Biochemistry**Three Hours: 3 Credits**

Principles and chemistry of living matter, their metabolism and energetic transformations, lipid structure and membranes are topics covered. Prerequisite: Chem. 304.

CHEM 572: Enzymology**Three Hours: 3 Credits**

Structure and functions of enzymes, enzyme kinetics, competitive, noncompetitive and cooperative binding of substrates to enzymes, reversible and irreversible binding of substrates to enzymes are topics covered. Prerequisite: CHEM 304, 571.

CHEM 573: Protein and Amino Acids**Three Hours: 3 Credits**

Advanced study of proteins, their building blocks and structure will be covered. Function and chemistry of amino acids and proteins, synthesis and purification will be studied. Prerequisite: CHEM 304 and CHEM 571.

CHEM 581: Advanced Techniques in Chemistry**Four Hours: 4 Credits**

Topics to be covered include modern synthetic methods in inorganic and organic chemistry, qualitative and quantitative analysis of reaction products using absorptiometric, fluorometric, electrochemical, separation and various other optical techniques. This is a hands-on course that emphasizes the profi-

ciency of students in the general research techniques/instrument usage in chemical sciences. Prerequisite: CHEM 314, 312, and 408.

CHEM 600: Advances in Biochemistry**Three Hours: 3 Credits**

Rigorous treatment of molecules of biological importance, their fundamental applications to the understanding of human function and the environmental effects on their activity will be covered. Topics covered include the general structure, function and energetics of proteins, enzymes, carbohydrates and the nucleic acids with emphasis on their utilization by living organisms, their impact on environment and other recent health related applications. Prerequisites: CHEM 571/573 or Consent of Instructor.

CHEM 601: Environmental Chemistry**Three Hours: 3 Credits**

This environmental chemistry course is a course designed to introduce students to the importance of chemistry in solving the myriad of environmental problems in the universe — the atmosphere, biosphere, geosphere, hydrosphere and the anthrosphere. Most of the pollutants are man-made during the normal course of daily activities. Environmental chemistry studies the production of pollutants, their distribution in the environment, overall health effects and their remediation using chemical knowledge and its attendant techniques. Prerequisite: CHEM 204, MATH 114 or equivalent, CHEM 207 or permission of the Instructor.

CHEM 602: Pollutants in the Environment**Three Hours: 3 Credits**

This course involves a rigorous treatment of materials and particulates that contribute to environmental hazards. Their origin and production will be covered in great depth. Rigorous quantitative methods of analysis and the general instrumental techniques will be covered. Prerequisite: CHEM 314 and/or CHEM 601.

CHEM 603: Physical Chemistry of Environmental Sciences**Three Hours: 3 Credits**

This course will cover the importance of fundamental thermodynamics and kinetics in the treatment of environmental problems. Topics covered will include first, second and third laws of thermodynamics, phase transformations, free energy changes, equilibrium, transport phenomena, catalysis. Prerequisite: CHEM 308 or equivalent.

CHEM 604: Analytical Techniques in Environmental Chemistry**Three Hours: 3 Credits**

This course covers the fundamental analytical methods used in the determination of both trace and bulk materials of chemical interest. Such techniques include errors in analysis and their propagation. Significance testing and ANOVA and Monte Carlo technique, optimization and computer simulations will be covered. Emphasis will be on the analysis of environmental pollutants. Prerequisite: CHEM 314 and/or CHEM 533.

CHEM 605: Atmospheric Chemistry**Three Hours: 3 Credits**

Chemistry of the lower atmosphere (troposphere and stratosphere) including photochemistry, kinetics, thermodynamics, box modeling, biogeochemical cycles and measurement techniques for atmospheric pollutants; study of important impacts to the atmosphere which result from anthropogenic emissions of

pollutants, including acid rain, the greenhouse effect, urban smog and stratospheric ozone depletion.
Prerequisite: CHEM 602 and CHEM 603.

CHEM 788, 789: Supervised Research in Chemistry

8 Credit Hours/4 Hours Each

These are research courses designed to enable students to participate in research in the areas of their competence under the supervision of qualified faculty members. Students are required to submit oral presentations of research findings in seminars and to submit a written thesis report to the graduate faculty.

CHEM 790: Graduate Seminar

Two Hours: 2 Credits

This course explores in-depth reviews of modern scientific topics in chemistry. It enables students engaged in this course to review the literature and provide discussions on the topics.

CHEM 797: Thesis Guidance

Two Hours: 2 Credits

CHEM 798: Thesis Research

Three Hours: 3 Credits

CHEM 799: Thesis Seminar

Three Hours: 3 Credits

DEPARTMENT OF PHYSICS**EASC 521: Earth Science****Four Hours: 3 Credits**

An overview of earth systems with emphasis on energy sources, earth system cycles, their interactions, and change with time. The solid earth, hydrosphere, and atmosphere will be studied using basic chemical and physical principles. The course will include lecture and laboratory. Prerequisite: Consent of instructor.

EASC 524: Planetary Science**Four Hours: 3 Credits**

This course is a comprehensive study of planetary systems with emphasis on chemical and physical processes that formed and influenced members of the planetary system. In addition to the inner and outer solar system planets, the course will also discuss the primitive objects in the solar system comets, asteroids, and meteorites. Prerequisite: Consent of instructor.

PHYS 500: Mathematical Physics**Three Hours: 3 Credits**

This course is the study of matrices, tensors, linear transformations, complex variables, Fourier and Laplace transformations with applications to physics. Prerequisite: Consent of instructor.

PHYS 511: Classical Mechanics**Three Hours: 3 Credits**

Lagrangian and Hamiltonian mechanics, normal modes, phase space, non-linear mechanics, numerical methods, stability. Prerequisite: PHYS 500.

PHYS 523: Nuclear Physics**Three Hours: 3 Credits**

The course is structured to develop an in-depth understanding of nuclear physics. Topics considered are nuclei, radioactivity, and nuclear models. Prerequisite: PHYS 528 or consent of instructor.

PHYS 524: Elementary Particles Physics & Relativity**Three Hours: 3 Credits**

The course is structured to develop an in-depth understanding of special relativity and elementary particles. Prerequisite: PHYS 528 and consent of instructor.

PHYS 525: Computational Physics**Four Hours: 3 Credits**

This course is designed to teach computer simulation of processes that occur in nature and visualization of scientific data using a computer. Prerequisite: PHYS 500.

PHYS 526: Biophysics**Four Hours: 3 Credits**

A survey of photobiology, bioenergetics, and physical methods currently used in biomedical research and practice, including microscopy, UV-visible spectrophotometry, diffraction, and physical separation techniques. Prerequisite: Consent of instructor.

PHYS 527: Acoustics**Four Hours: 3 Credits**

This course presents the physical and mathematical principles underlying the generation, transmission and reception of acoustic waves. Selected topics in architectural, environmental, industrial, and underwater applications are also considered. Prerequisite: PHYS 500 or consent of instructor.

PHYS 528: Quantum Mechanics I**Three Hours: 3 Credits**

This course explores fundamental concepts in quantum mechanics and solutions of the Schrödinger equation. It includes representation of dynamical variables as operators and matrices and symmetry in quantum mechanics. Prerequisite: PHYS 500.

PHYS 529: Quantum Mechanics II**Three Hours: 3 Credits**

This course deals with approximation methods in quantum mechanics, quantum mechanical effects of identical particles, and scattering theory. Prerequisite: PHYS 528.

PHYS 530: Solid State Physics**Three Hours: 3 Credits**

Crystal structure, crystal binding, crystal vibrations, thermal properties, free electron gas, band structure of solids, metals, semiconductors, dielectric and optical properties of insulators, and magnetic properties. Prerequisite: PHYS 528.

PHYS 531: Electromagnetic Theory**Three Hours: 3 Credits**

Electrostatics and boundary value problems, magnetic fields, Maxwell's equation, electromagnetic waves in dielectrics, metals and crystals, wave guides, radiation, potentials, and multipoles. Prerequisite: PHYS 500.

PHYS 535: Survey of Current Materials Physics**Three Hours: 3 Credits**

Crystallography, diffraction and microscopy techniques, defects, diffusion, phase diagrams, order-disorder transformations, interfacial phenomena, nucleation, and solidification. Prerequisite: Consent of instructor.

PHYS 788, 789 Supervised Research in Physics**Four Hours: 4 Credits each course**

These are research courses designed to enable students to participate in research in the areas of their competence under the supervision of qualified faculty members. Students are required to submit oral presentations of research findings in seminars and to submit a written thesis report to the graduate faculty.

PHYS 790, 791 Seminars in Physics**One Hour: 1 Credit each course**

This course explores in-depth reviews of modern scientific topics in physics. It enables students engaged in this course to review the literature and provide discussions of the topics.

PHYS 797, 799 Thesis Guidance

DEPARTMENT OF MATHEMATICS**MATH 501: Set Theory and Related Topics****Three Hours: 3 Credits**

A study of axioms and operations, relations and functions, construction of real numbers, cardinal numbers, the Axiom of Choice, ordering and ordinals, other types, and special topics.

MATH 505: Abstract Algebra I**Three Hours: 3 Credits**

A study of groups, subgroups, homomorphisms, factor groups, products, Sylow's Theorem, symmetric groups, free groups, ring homomorphisms, ideals, and quotient rings.

MATH 506: Abstract Algebra II**Three Hours: 3 Credits**

A study of rings, ideals, maximal ideals, integral domains, polynomial rings, field of quotient of an integral domain, fields, vector spaces, field extensions, root of polynomials, finite fields, and special topics

MATH 507: Ordinary Differential Equations**Three Hours: 3 Credits**

A study of the modern theory of Ordinary Differential Equations and dynamic system including existence and uniqueness theorem, system of differential equations, variation of parameters, Laplace transform, stability of equilibrium solutions, stability of linear system, Phase-plane analysis, stable and unstable and center manifolds, and bifurcation theory.

MATH 512: Probability and Statistics**Three Hours: 3 Credits**

A study of relation of probability and statistical theory to practical problems, probability theory, infinite sample spaces, random variables distributions, testing hypotheses, sampling, correlation and regression.

MATH 514: Applied Combinatorics and Graph Theory**Three Hours: 3 Credits**

This course deals with applications of graph theory and combinatorics in the social and life sciences. Topics to be discussed include graph algorithms, transport networks, RNA structures.

MATH 517: Foundations of Geometry**Three Hours: 3 Credits**

A study of the axiomatic method for development of geometrical systems, the axioms of Euclid and Hubert, topics in Euclidean geometry, geometry of four dimensions, and plane hyperbolic geometry.

MATH 518: Modern Geometry**Three Hours: 3 Credits**

An introduction to various types of geometries as developed from sets of assumptions. Finite geometries, topics from Euclidean, projective and non-Euclidean geometries. Consideration of synthetic and analytic approaches.

MATH 521: Real Analysis I**Three Hours: 3 Credits**

A study of the real number system, metric spaces, functions, sequences, limits, continuity, point sets, differentiation, and integration. Emphasis will be on basic ideas rather than the manipulative techniques of calculus.

MATH 522: Real Analysis II**Three Hours: 3 Credits**

A continuation of MATH 521 to include transcendental functions, infinite series, expansion of functions, and convergence.

MATH 523: Measure Theory**Three Hours: 3 Credits**

A study of the set algebra and set operations, set functions, convergence of measure sequences, measure spaces and Lebesgue-Stieltjes measure, measure functions, convergence in measure and almost everywhere convergence, and signed measures.

MATH 525: Theory of Numbers**Three Hours: 3 Credits**

A study of fundamental laws, linear-diophantine equations, property of integers congruencies, Theorems of Fermat and Wilson, quadratic residues.

MATH 527: Complex Analysis**Three Hours: 3 Credits**

A study of functions of one variable, topics include multi-valued functions, branch cut, applications of residues, conformal mappings, Riemann mapping theorem, Schwarz-Christofel mapping, application to two dimensional fluid mechanics, and special topics.

MATH 541: Point Set Topology I**Three Hours: 3 Credits**

A study of properties of metric and topological spaces, continuous functions, and applications to Euclidean spaces.

MATH 542: Point Set Topology II**Three Hours: 3 Credits**

A continuation of MATH 541 to include axioms, quotients and products, compactness and connectedness, metrization, Stone-Cech compactification, and paracompact spaces.

MATH 551: Algorithms and Computations I**Three Hours: 3 Credits**

A study of features and basic data structures of a high-level programming language. Algorithm construction and methods for evaluating efficiency of algorithms are studied.

MATH 552: Algorithms and Computations II**Three Hours: 3 Credits**

A study of techniques in design and analysis of computations; algorithms are developed and applied. The data structures which enhance algorithm design and implementation are studied. Implementation is done in high-level language capable of structured, modular programming.

MATH 553: Computational Mathematics**Three Hours: 3 Credits**

A study of numerical techniques for the solution of problems arising in biological and physical sciences including the treatment of typical problems in applications with special emphasis on the type of data encountered in practice.

MATH 555: Introduction to Functional Analysis**Three Hours: 3 Credits**

This course is designed to introduce the students to the modern theory of Functional Analysis. Topics discussed include: Linear mappings; Metrization; Seminorms and local convexity; completeness; The Hahn-Banach Theorem; Weak Topologies; Duality in Banach Spaces; Hilbert Spaces and Operators on Hilbert space; and some applications.

MATH 557: Foundation of Harmonic Analysis**Three Hours: 3 Credits**

This course is designed to introduce the students to various topics related to tools, techniques and applications of the theory of Harmonic Analysis. Topics to be discussed include: Fourier series on T ; Convergence of Fourier series; Interpolation of Linear operators; Fourier transforms on the line; Fourier Analysis on local compact Abelian groups; Almost Periodic Functions.

MATH 559: Numerical Analysis**Three Hours: 3 Credits**

This course is designed to derive and apply techniques of numerical analysis and computational mathematics. Topics include: arithmetic and well-posed computations; Gaussian elimination; functional iteration for a single equation and for a system of equations; computation of eigenvalues and eigenvectors; Weierstrass' approximation theorem; the pointwise error in interpolation polynomials; Hermit interpolation and Chebyshev polynomials; finite elements method.

MATH 561: Mathematical Modeling**Three Hours: 3 Credits**

The course is designed to study the formulations of abstract mathematical models for real phenomena. It provides an introduction to the theory of model construction as a formal system, examines a variety of applications of the theory and provides practice in the building models.

MATH 575: Introduction to Partial Differential Equations**Three Hours: 3 Credits**

A study of the modern theory of partial differential equations including wave equations, heat equations, Laplace equations, Maximum principles, distributions, Sobolev spaces, linear elliptic equations, energy method for evolution problems, and semigroup methods.

MATH 631: Biostatistics**Three Hours: 3 Credits**

A first course in statistics with emphasis on applications in biological and health sciences, including organizing and summarizing data, basic probability, probability distributions, sampling distributions, drawing inferences from population samples via estimation and significance tests, linear regression, analysis, analysis of frequencies, vital statistics, and exposure to analysis of variance. Students will perform computer projects via statistical software system.

MATH 632: Advanced Biostatistics**Three Hours: 3 Credits**

A continuation of MATH 631 with emphasis on analyzing data arising in the health and life sciences to include advanced inferential statistical methods, analysis of variance, simple and multiple regression and correlation analysis, chi-square analysis of frequencies, and nonparametric statistical methods.

MATH 633: Applied Regression and Correlation Analysis**Three Hours: 3 Credits**

The study of relationships among variables, including linear regression with one or more independent variables, methods of estimating parameters and testing hypotheses, diagnostics and remedial measures, selection of independent variables via stepwise and other forms of regression techniques, model building, nonlinear regression, and time series.

MATH 788-789: Supervised Research**Six Hours: 3 Credits each course**

These courses are designed to enable students to participate in research in areas of their competence under the supervision of qualified individuals. Students are required to submit research findings orally in a seminar and to submit a written report to the graduate faculty.

MATH 797: Thesis Guidance 3 Hours: 2 Credits**MATH 799: Thesis Seminar Three Hours: 3 Credits**

DEPARTMENT OF COMPUTER SCIENCE

Bioinformatics Program

BIOI 511: Bioinformatics I

Three Hours: 3 Credits

The course introduces principles, concepts, methods, techniques, algorithms, tools, and strategies to transform and process the masses of information from biological experiments focusing particularly on sequence data. It covers topics as: DNA and protein sequence alignment and analysis, sequence analysis software, database searching, database search heuristic algorithms, sequence alignment dynamic programming algorithms, RNA folding, and multiple sequence alignment and analysis.

BIOI 512: Bioinformatics II

Three Hours: 3 Credits

The course introduces principles, concepts, methods, techniques, algorithms, tools, and strategies of structural bioinformatics. It covers topics such as: protein structure, DNA and RNA structure, macromolecular structure determination techniques, data representation and databases, comparative features, structure-function assignment, protein interactions, and protein structure predictions.

BIOI 513: Bioinformatics III

Three Hours: 3 Credits

The course is an advanced treatment of various research topics introduced in BIOI.511 and BIOI.512. Bioinformatics techniques applied in functional and comparative genomics such as mRNA expression arrays, studying functions of nonprotein-coding sequences, proteomic techniques to measure the population of proteins in the cell—including mass spectroscopy and protein-based arrays will be covered. The course will also provide an in-depth survey of research involving the applicability and limitations of these approaches.

BIOI 521: Bioinformatics Tools and Databases

Three Hours: 3 Credits

The course introduces bioinformatics tools and databases for processing and management biological data available through the World Wide Web. It covers topics as: bioinformatics tools and databases at the National Center for Biotechnology Information, protein resources at the European Molecular Biology Laboratory, and Biology Workbench at the San Diego Supercomputer Center.

BIOI 531: Bioprogramming

Three Hours: 3 Credits

The course introduces programming languages Perl, object-oriented Perl, and BioPerl and presents how to program in bioinformatics. It covers topics as: data types, operators, control structures, functions, regular expressions, files and directories, references, report writing, object-oriented programming, classes, and utility programs for analysis and interpretation of biological structures and data.

BIOI 542: Biovisualization

Three Hours: 3 Credits

The course introduces principles, concepts, methods, techniques, algorithms, tools, and strategies for visualization of biological data using different visualization software tools. It covers topics such as

volume rendering, visualizing vector data, virtual environments, visualization tools, applications in bioinformatics, and visualization challenges.

BIOI 591: Current Topics in Bioinformatics**Three Hours: 3 Credits**

This course provides the guidance and details concerning research necessary for posing and solving a thesis problem, writing a thesis, and publishing the thesis results.

BIOI 797: Thesis Guidance in Bioinformatics**Three Hours: 3 Credits**

This course provides the guidance and details concerning research necessary for posing and solving a thesis problem, writing a thesis, and publishing the thesis results.

BIOI 799: Thesis Seminar in Bioinformatics**Three Hours: 3 Credits**

This course is a seminar in bioinformatics. It covers new trends, topics, and state-of-the-art tools and techniques in bioinformatics that are not covered by other courses in the bioinformatics curriculum. The focus of this course will be on new/emerging (cutting-edge) areas of interest and research in bioinformatics.

COSC 541: Scientific Visualization**Three Hours: 3 Credits**

The course introduces principles, concepts, methods, techniques, algorithms, tools and strategies for scientific visualization. It covers topics such as perception, image techniques and data acquisition, surface extraction, volume visualization, methods for time-varying data, vector visualization, information visualization, virtual reality, and computer animation.

COSC 572: Genetic Algorithms and Programming**Three Hours: 3 Credits**

The course introduces principles, concepts, methods, techniques, tools, and strategies of genetic algorithms and programming. It focuses in depth on a small set of important and interesting topics particularly in machine learning, scientific modeling, and artificial life.