

DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY

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Faculty

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Dr. A. Hamme, Associate Professor
Dr. G. Hill, Assistant Professor
Dr. Md. Hossain, Assistant Professor
Dr. M. Huang, Associate Professor
Dr. K. Lee, Professor
Dr. J. Leszczynski, Presidential Distinguished
Professor
Dr. Y. Liu, Professor
Dr. E. Noe, Professor
Dr. P. Ray, Assistant Professor
Dr. R. Sullivan, Professor Emeritus
Dr. H. Tachikawa, Professor
Dr. R. Venkatraman, Associate Professor
Dr. J. D. Watts, Professor
Dr. J. Zubkowski, Professor

Program Description

The Department of Chemistry and Biochemistry offers both a Doctor of Philosophy (Ph.D.) and a Master of Science (M.S.) degree in Chemistry. The Ph.D. degree in chemistry requires evidences of high quality scientific research leading to peer-reviewed publications with classroom teaching, laboratory supervising, and proposal and manuscript writing experiences. The program covers all modern areas of chemistry including analytical, biochemistry, computational, environmental, inorganic, organic, and physical chemistry and interdisciplinary areas in material, energy, environmental, and biomedical research. The intensive graduate training includes formal lecture courses, hands-on laboratory and theoretical research experiences, teaching experiences, independent proposal development, preparation of manuscripts and preparation of research thesis/dissertation for publication.

Program Mission

The Department of Chemistry and Biochemistry will provide a comprehensive graduate education in all areas of modern chemistry and related fields for a diverse student body aiming for national and international distinction and produce high quality chemists for education institutions, governmental agencies, and industrial and business entities.

Program Objectives

- ◆ To provide the best education and career opportunity for students from the underrepresented minority groups with the best cultural and nurturing environment that is conducive to learning and scholarly activities.
- ◆ To provide opportunities in which students can develop methods of independent and systematic investigations leading to scientific discoveries.
- ◆ To prepare students for a successful career at academic institutions, industrial and business entities, and governmental agencies.
- ◆ To promote professional development and growth of the faculty.

Time Limits

For full-time students working toward an **M.S. degree**, the degree requirements should be completed by the end of the second year following the first semester of study. Students beyond their second year of full-time study will be reviewed by their thesis committee for satisfactory progress every semester. A report of unsatisfactory will result in dismissal from the program. Under special circumstances, MS students must graduate in three years in fulltime status. Part time students are considered separately.

For full-time students working toward a **Ph.D. degree**, we recommend that the final defense be completed within five years. Under special circumstances, Ph.D. students must graduate in eight years in fulltime status. Part time students are considered separately. Students beyond their fifth year of full-time study will be reviewed by their dissertation committee for satisfactory progress every semester. A report of unsatisfactory will result in dismissal from the program. The student will be allowed to apply for a Masters degree in this case.

Doctoral Program in Chemistry

Admission Requirements

In addition to the requirements of the Division of Graduate Studies, applicants must have the following:

- ◆ A B.S. degree in chemistry or a closely related field with passing grades 'C' or better for the following courses with labs:
 - 2 semesters of General Chemistry
 - 2 semesters of Organic Chemistry
 - 1 semester of Analytical Chemistry
 - 1 semester of Physical Chemistry
 - 1 semester of Inorganic Chemistry
- ◆ GRE Score*
- ◆ Three Letters of Recommendation
- ◆ A Statement of Purpose for Graduate Study

(* Students who have difficulty taking the GRE can take the Department's entrance exam instead)

Retention Requirements

In addition to satisfying the basic requirements of the Division of Graduate Studies, students are required to

maintain a chemistry GPA of 3.00 or higher every semester. Seminar courses, dissertation courses, and other non-chemistry elective courses are excluded from the calculation of the chemistry GPA. Students whose chemistry GPA is below 3.00 will be placed on probation for one semester to fix the deficiencies.

Repeating a Course

If a student receives a grade of “C” or lower in a chemistry core course or a course in the student’s major field of study, that course must be retaken and the student must earn a grade of “B” or better.

Degree Candidacy Requirements

After completing the lecture and seminar course requirements, students need to take and pass the comprehensive examination and defend an independent research proposal in order to become an official Ph.D. candidate. The comprehensive examination of 3 subjects must be taken and passed during the second year of study and the written independent research proposal must be prepared and defended during the third year of study and at least one year before graduation.

Graduation Requirements

The minimum number of credit hours for the Ph.D. degree in Chemistry is 60 credit hours.

- ◆ 18 credit hours from graduate Chemistry lecture courses
- ◆ 2 credit hours for Seminars
- ◆ 40 credit hours for Dissertation Research
- ◆ Teach 1-2 semesters of undergraduate courses as a teaching assistant.
- ◆ Pass Area Comprehensive Examination in three subject areas.
- ◆ Write and defend an Independent Research Proposal.
- ◆ Defend the dissertation before the Dissertation Committee and public audience.
- ◆ Submit an approved dissertation to the Division of Graduate Studies with one copy to the Department and one to the University Library

The 18 credit hours of lecture courses must include at least three out of the following five core courses for a total of at least 9 credit hours:

CHEM 723	Advanced Analytical Chemistry
CHEM 731	Advanced Biochemistry
CHEM 736	Physical Organic Chemistry
CHEM 741	Advanced Inorganic Chemistry
CHEM 758	Quantum Chemistry

Students entering the Ph.D Program with a M.S. Degree in Chemistry

Students who earned a M.S. degree from another institution, are allowed to transfer up to three (3) lecture courses or 9 credit hours if these courses are equivalent to the JSU chemistry doctoral courses. Students who earned a M.S. degree from JSU will be required to take at least two more approved lecture courses instead of the required six lecture courses.

Other requirements are the same as for those entering the Ph.D. program with a B.S. degree.

Master’s Program in Chemistry

Admission Requirements

In addition to the requirements of the Division of Graduate Studies, applicants must have the following:

1. A B.S. degree in chemistry or a closely related field with passing grade (“C” or better) in the following courses with labs:
 - 2 semesters of General Chemistry
 - 2 semesters of Organic Chemistry
 - 1 semester of Analytical Chemistry
 - 1 semester of Physical Chemistry
 - 1 semester of Inorganic Chemistry
2. Three Letters of Recommendation
3. A Statement of Purpose for Graduate Study

Retention Requirements

In addition to satisfying the basic requirements of the Division of Graduate Studies, students are required to maintain a chemistry GPA of 3.00 or higher every semester. Seminar courses, dissertation courses, and other non-chemistry elective courses are excluded from the calculation of the chemistry GPA. Students whose chemistry GPA is below 3.00 will be placed on probation for one semester to fix the deficiencies.

Degree Requirements

A student pursuing a M.S. degree in Chemistry is required to complete a minimum of 30 hours with a thesis in Chemistry.

1. Within the 18 credit hours of lecture courses, students must complete at least three (3) of five (5) core courses for a total of nine (9) hour and two semesters of seminar for one (1) credit hour. The core courses are:
 - CHEM 523 Advanced Analytical Chemistry
 - CHEM 541 Advanced Inorganic Chemistry
 - CHEM 531 Biochemistry
 - CHEM 558 Quantum Chemistry
 - CHEM 536 Physical Organic Chemistry
2. Students will fulfill the remaining 20 hours from Chemistry electives with no more than 11 hours in CHEM 580-Thesis Research. It is possible to take some courses in related fields upon recommendation of the advisor.
3. Pass the Graduate Area Comprehensive Examination in three chemistry areas.
4. The student must participate as a teaching assistant in the chemistry department for at least one semester.
5. Defend a thesis before the Thesis Committee and public audience.
6. Submit an approved thesis to the Division of Graduate Studies with one copy to the Department and one to the University Library

Non-Thesis Master's Degree

Ph.D. students who fulfill the following requirements will be awarded a Non-Thesis Master's degree in Chemistry if the students apply.

1. A minimum of 36 credit hours, including at least 18 hours of approved graduate level lecture courses and two hours of seminar with a GPA of 3.00 or better. The graduate lecture courses should include at least three of the five core courses: Advanced Analytical Chemistry, Advanced Inorganic Chemistry, Biochemistry, Quantum Chemistry, and Physical Organic Chemistry.
2. Pass the Graduate Area Comprehensive Examination in three areas.
3. Pass an oral defense covering the student's research before a committee of four faculty members.

DESCRIPTION OF COURSES

Master-level Courses

CHEM 511 Chemistry Seminar. (1 Hour) Presentation and discussion of current chemical topics and research by students, faculty and visiting speakers. Prerequisite: Permission of instructor.

CHEM 523 Advanced Analytical Chemistry. (3 Hours) Prerequisites: Courses in Analytical Chemistry and Physical Chemistry. Principles and application of selected analytical methods including electrochemistry, spectroscopy and selected topics of unusual current interest.

CHEM 526 Electroanalytical Chemistry. (3 Hours) Prerequisite: Advanced Analytical Chemistry. Discussion of potentiometric, conductometric, polarographic, amperometric, coulometric, controlled potential and stepping analysis and related techniques. Emphasis is also placed on theoretical considerations and applications to studies of chemical and charge transfer equilibria and kinetics.

CHEM 531, 532 Biochemistry. (3 Hours) Prerequisite: One year of Organic Chemistry. The chemical composition of living matter and the chemical mechanics of life processes.

CHML 531, 532 Biochemistry Laboratory. (1 Hour) Prerequisite: Chemistry 531 and 532. Basic purification and characterization techniques in Biochemistry.

CHEM 536 Physical Organic Chemistry. (3 Hours) Prerequisites: Physical Chemistry and Organic Chemistry. A study of organic molecular structure, Woodward Hoffmann Rules, substituents effects, intra- and intermolecular forces, kinetics and stereochemistry.

CHEM 541 Advanced Inorganic Chemistry. (3 Hours) Prerequisite: An undergraduate course in Physical Chemistry. A study of inorganic compounds with the application of Physical Chemistry principles to thermodynamic, kinetic and structural problems.

CHEM 553 Thermodynamics. (3 Hours) Prerequisite: Physical Chemistry. Principles of thermodynamics and their application to chemical and phase equilibria.

CHEM 558 Quantum Chemistry. (3 Hours) Prerequisite: Physical Chemistry. Principles and applications of quantum theory.

CHEM 580 Thesis Research. (Variable 1-6 Hours) Prerequisite: Permission of adviser. Selected topics arranged in consultation with the staff; includes literature, research, and laboratory investigation of a problem.

Doctoral-level Courses

CHEM 711 Seminar (0.5 Hour) Presentation and discussion of current chemical topics and research by visiting speakers, faculty and students.

CHEM 721 Advanced Instrumental Analysis (3 Hours). Prerequisite: Analytical Chemistry and Physical Chemistry (two semesters). Theoretical principles and laboratory techniques involved in characterization of chemical systems using instrumental methods. This one semester course will present the following topics of interest: absorption and emission spectrometry, mass spectrometry, liquid and gas chromatography, and electrophoresis. A laboratory series on spectro-photometry, fluorometry, atomic absorption spectrometry, inductively coupled plasma atomic emission spectrometry, FT-IR, gas chromatography-mass spectroscopy, and high performance liquid chromatography are included in this

CHEM 723 Advanced Analytical Chemistry (3 hours) Prerequisite: Analytical Chemistry and Physical Chemistry (two semesters). Principles and application of analytical methods including acid-base titrations, redox titrations, titrations which involve metal-ligand complexes, gravimetric analysis, separation methods (chromatography), and electroanalytical chemistry.

CHEM 726 Electroanalytical Chemistry (4 hours) Prerequisite: Advanced Analytical Chemistry. Principles and application of all modern electrochemical methods such as voltametrics, chronoamperometry, spectroelectrochemistry, and thin layer electrochemistry etc. Electrode kinetics and mass transfer are discussed in detail.

CHEM 729 Spectroscopic Methods (3 hours) Prerequisite: Analytical Chemistry. Study of the theoretical principles of advanced spectroscopic topics used in analytical chemistry. Some examples of the topics to be covered are: X-ray methods (absorption, fluorescence, diffraction), surface spectroscopy and chemical analysis of surfaces, (Ion Scattering Spectroscopy, ISS), Auger Emission Spectroscopy (AES), electron Spectroscopy for chemical analysis (ESCA), Secondary Ion Mass Spectrometry (SIMS), Electron Spin Spectroscopy (ESR), Nuclear Magnetic Resonance Spectroscopy (NMR).

CHEM 731 Advanced Biochemistry I (3 hours) Prerequisite: Organic Chemistry (two semesters). Comprehensive coverage of major areas of biochemistry. Topics covered include proteins, enzymology, bioenergetics, the chemistry and intermediary metabolism of carbohydrates, lipids, proteins and nucleic acids.

CHEM 732 Advanced Biochemistry II (3 hours)

Prerequisite: Advanced Biochemistry I. Comprehensive coverage of major areas of biochemistry. Topics covered include storage, transmission, and expression of genetic information, molecular immunology, membrane transport and hormone action.

CHML 731 Advanced Biochemistry Laboratory (1 hour) Corequisite: Advanced Biochemistry I. Selected techniques in areas covered in CHEM 731.

CHML 732 Advanced Biochemistry Laboratory (1 hour) Corequisite: Advanced Biochemistry II. Selected techniques in areas covered in CHEM 732.

CHEM 733 Advanced Molecular Biology (3 hours) Molecular mechanisms involved in replication, expression and regulation of prokaryotic genes. Topics include: DNA replication, repair, recombination, restriction-modification, recombinant DNA technology, plasmids and transposons, RNA transcription, processing and message splicing.

CHEM 734 Physical Biochemistry (3 hours) Characterization of macromolecules, hydrodynamic methods, multiple equilibria, macromolecule-ligand interactions.

CHEM 736 Physical Organic Chemistry (3 hours) Prerequisite: Organic Chemistry (two semesters). A study of organic molecular structure, Woodward Hoffmann Rules, substituents effects, intra- and intermolecular forces, kinetics and stereochemistry.

CHEM 738 Organic Synthesis (3 hours) Prerequisite: Organic Chemistry (two semesters). The course covers the formation of carbon-carbon and carbon-heteroatom bonds, functionalization and interconversion of functional groups, reactions of organic reagents, protective groups, total synthesis and asymmetric synthesis in organic synthesis.

CHEM 741 Advanced Inorganic Chemistry (3 hours) Prerequisite: Advanced Inorganic Chemistry (CHEM 441). A study of symmetry and group theory, bonding and structures of inorganic compounds, coordination chemistry and acid-base chemistry.

CHEM 743 Structural Inorganic Chemistry (3 hours) Prerequisite: Any 700 level course. A study included concepts of the solid state as explored by crystallography. It covers symmetry, polyhedra, sphere packing, tetrahedral and octahedral structures of inorganic compounds.

CHEM 747 Inorganic Reaction Mechanisms (3 hours) Prerequisite: Any 700 level course. The topics include mechanism of reactions of certain inorganic compounds, stereochemical changes in complexes, redox reactions, homogeneous and heterogeneous catalysts.

CHEM 749 Organometallic Chemistry (3 hours) Prerequisite: Physical Organic Chemistry (CHEM 736) or equivalent. A study of formation, stability, and reactivity of metal-carbon bond of main group and transition metal. It will cover the usage of organometallics in organic synthesis and catalysis.

CHEM 752 Atomic and Molecular Spectroscopy (3 hours) Prerequisite: Physical Chemistry (two semesters). A comprehensive course covering

concepts and methods of modern atomic and molecular spectroscopy. Subjects covered include electric phenomena, absorption and emission of radiation, atomic spectroscopy, rotational spectroscopy, vibrational spectroscopy, electronic spectroscopy, and magnetic resonance spectroscopy.

CHEM 753 Thermodynamics (3 hours) Prerequisite: Physical Chemistry (two semesters). Laws of thermodynamics and their chemical applications. Introduction to chemical kinetics and statistical mechanics.

CHEM 754 Kinetics (3 hours) Prerequisite: Physical Chemistry (two semesters). Mechanics of chemical reactions, cross sections, and rate constants. Elastic, inelastic, and rearrangement channels are discussed, using quantum and semiclassical techniques.

CHEM 755 Mechanisms of Organic Chemistry (3 hours) Prerequisite: Organic Chemistry (two semesters). A study of mechanistic aspects of organic reactions included the rate theory, and reaction mechanism, experimental methods and treatment of data.

CHEM 758 Quantum Chemistry (3 hours) Prerequisite: Physical Chemistry (two semesters). (Computational Chemistry) Important concepts of quantum chemistry at the intermediate level, including angular momentum, perturbation theory, electronic structure of molecules, and radiation matter interaction. Applications will vary from year to year.

CHEM 763 Statistical Mechanics (3 hours) Prerequisite: Physical Chemistry (two semesters) A study of statistical mechanical ensembles, partition functions and their relationship to thermodynamics, lattice statistics, molecular distribution and correlation functions, the theories of liquids and solutions, phase transitions, and cluster theory.

CHEM 780 Dissertation - (1 - 9 hours)

CHEM 782 Special Topics in Analytical Chemistry - (3 hours) Selected topics not covered in regularly scheduled courses, and current research topics in analytical chemistry.

CHEM 783 Special Topics in Biochemistry - (3 hours) Selected topics not covered in regularly scheduled courses, and current research topics in biochemistry.

CHEM 784 Special Topics in Organic Chemistry - (3 hours) A course in a specific area of organic chemistry such as structure determination in organic chemistry, or current research subject not covered in regularly scheduled courses presented to fit the interests of advanced students.

CHEM 785 Special Topics in Inorganic Chemistry - (3 hours) Topics include subjects of current research in inorganic chemistry, but not covered in regularly scheduled courses.

CHEM 786 Special Topics in Physical Chemistry - (3 hours) Topics vary from year to year will include subjects such as photochemistry, solid state, surface chemistry, and radiation chemistry.