### COURSE SYLLABUS

<table>
<thead>
<tr>
<th>Course Number: CHM 3120</th>
<th>Course Title: Analytical Chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisite(s): CHM 1046 with passing grade.</td>
<td></td>
</tr>
<tr>
<td>Course Credit: 2</td>
<td>Course Hours: 2 per week</td>
</tr>
<tr>
<td>Department: Chemistry</td>
<td></td>
</tr>
<tr>
<td>Faculty Name: Dr. Nelly Mateeva</td>
<td>Term and Year: Fall 2009</td>
</tr>
<tr>
<td>Office Location: 112 FSH (Science Research Building)</td>
<td>Place and Time: 211 BLPC (General Classroom Bldg) MW 10:10-11:00am</td>
</tr>
<tr>
<td>Office Hours</td>
<td>Telephone: 850-412-5662</td>
</tr>
<tr>
<td>Monday 2:30-5:30 pm</td>
<td>e-mail: <a href="mailto:nelly.mateeva@famu.edu">nelly.mateeva@famu.edu</a>, <a href="mailto:nellymateeva@yahoo.com">nellymateeva@yahoo.com</a></td>
</tr>
</tbody>
</table>

### Course Description

Topics include a review of stoichiometry, acid-base equilibria, statistical treatment of data, and an introduction to volumetric, gravimetric, potentiometric, and photometric methods of analysis. Chemical equilibria are treated mathematically.

### Course Purpose

Required course for chemistry majors.

### References

The Conceptual Framework in the Professional Education Unit (PEU) at Florida A&M University is an integrated approach to providing educational experiences that result in exemplary professional educators. The Framework is comprised of six themes with the mission of developing high quality classroom teachers, administrators and support personnel. The term “exemplary” refers to the kind of graduates the PEU strives to produce. The figure below provides a diagram of the Exemplary Professional Conceptual Framework:

### TECHNOLOGY

**• CF 2**

*Through this focal area, the FAMU professional education candidate will:*

<table>
<thead>
<tr>
<th>CF: 2.1 (S)</th>
<th>Use of available technology and software to support student learning.</th>
<th>F: 4,12</th>
<th>I: 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF: 2.5 (S)</td>
<td>Use fundamental concepts in technology.</td>
<td>F: 12</td>
<td>I: 6</td>
</tr>
<tr>
<td>CF: 2.7 (S)</td>
<td>Facilitate the use of technology by students.</td>
<td>F: 4,12</td>
<td>I: 6</td>
</tr>
</tbody>
</table>

### VALUES

**• CF 3**

*Through this focal area, the FAMU professional education candidate will:*

<table>
<thead>
<tr>
<th>CF: 3.4(D)</th>
<th>Be committed to individual excellence.</th>
<th>F: 11</th>
<th>I: 5,9</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF: 3.5(D)</td>
<td>Recognize the importance of peer Relationships in establishing a climate for learning.</td>
<td>F: 2, 7, 11</td>
<td>I: 5,10</td>
</tr>
</tbody>
</table>

### CRITICAL THINKING

**• CF 4**

*Through this focal area, the FAMU professional education candidate will:*

<table>
<thead>
<tr>
<th>CF: 4.3 (D)</th>
<th>Value critical thinking and self-directed learning as habits of mind.</th>
<th>F: 4</th>
<th>I: 1,4</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF: 4.5 (S)</td>
<td>Demonstrate the use of higher order thinking skills.</td>
<td>F: 8</td>
<td>I: 4</td>
</tr>
</tbody>
</table>
PROFESSIONALISM

- CF 5
- Through this focal area, the FAMU professional education candidate will:

| CF: 5.1 (K) | Know the content | F: 8 | I: 1 |

National and State Standards Addressed in the Course

Interstate New Teacher Assessment and Support Consortium (INTASC) Standards

**Standard 1: Subject Matter:** The teacher understands the central concepts, tools of inquiry, and structures of the discipline(s) he or she teaches and can create learning experiences that make these aspects of subject matter meaningful for students.

**1.10 Knowledge**
1.12 The teacher understands how students’ conceptual frameworks and their misconceptions for an area of knowledge can influence their learning.

1.13 The teacher can relate his/her disciplinary knowledge to other subject areas.

**1.20 Dispositions**
1.24 The teacher is committed to continuous learning and engages in professional discourse about subject matter knowledge and children's learning of the discipline.

**1.30 Performances**
1.35 The teacher develops and uses curricula that encourage students to see, question, and interpret ideas from diverse perspectives.

**Standard 4: Instructional Strategies:** The teacher understands and uses a variety of instructional strategies to encourage students' development of critical thinking, problem solving, and performance skills.

**4.10 Knowledge**
4.11 The teacher understands the cognitive processes associated with various kinds of learning (e.g. critical and creative thinking, problem structuring and problem solving, invention, memorization and recall) and how these processes can be stimulated.

4.12 The teacher understands the principles and techniques, along with advantages and limitations, associated with various instructional strategies (e.g. cooperative learning, direct instruction, discovery learning, whole group discussion, independent study, interdisciplinary instruction).

4.13 The teacher knows how to enhance learning through the use of a wide variety of materials as well as human and technological resources (e.g. computers, audio-visual technologies, videotapes and discs, local experts, primary documents and artifacts, texts, reference books, literature, and other print resources).

**4.20 Dispositions**
4.21 The teacher values the development of students' critical thinking, independent problem solving, and performance capabilities.

4.23 The teacher values the use of educational technology in the teaching and learning process.

**4.30 Performances**

4.31 The teacher carefully evaluates how to achieve learning goals, choosing alternative teaching strategies and materials to achieve different instructional purposes and to meet student needs (e.g. developmental stages, prior knowledge, learning styles, and interests).

4.33 The teacher constantly monitors and adjusts strategies in response to learner feedback.

4.34 The teacher varies his or her role in the instructional process (e.g. instructor, facilitator, coach, audience) in relation to the content and purposes of instruction and the needs of students.

4.36 The teacher uses educational technology to broaden student knowledge about technology, to deliver instruction to students at different levels and paces, and for advanced levels of learning.

**Standard 5, Learning Environment**

The teacher uses an understanding of individual and group motivation and behavior to create a learning environment that encourages positive social interaction, active engagement in learning, and self-motivation.

**5.10 Knowledge**

5.11 The teacher can use knowledge about human motivation and behavior drawn from the foundational sciences of psychology, anthropology, and sociology to develop strategies for organizing and supporting individual and group work.

5.12 The teacher understands how social groups function and influence people, and how people influence groups.

5.13 The teacher knows how to help people work productively and cooperatively with each other in complex social settings.

5.14 The teacher understands the principles of effective classroom management and can use a range of strategies to promote positive relationships, cooperation, and purposeful learning in the classroom.

5.15 The teacher recognizes factors and situations that are likely to promote or diminish intrinsic motivation, and knows how to help students become self-motivated.

**5.20 Dispositions**

5.21 The teacher takes responsibility for establishing a positive climate in the classroom and participates in maintaining such a climate in the school as a whole.

5.22 The teacher understands how participation supports commitment, and is committed to the expression and use of democratic values in the classroom.

5.23 The teacher values the role of students in promoting each other's learning and recognizes the importance of peer relationships in establishing a climate of learning.

5.24 The teacher recognizes the values of intrinsic motivation to students' life-long growth and learning.
5.25 The teacher is committed to the continuous development of individual students' abilities and considers how different motivational strategies are likely to encourage this development for each student.

5.30 Performances
5.31 The teacher creates a smoothly functioning learning community in which students assume responsibility for themselves and one another, participate in decision making, work collaboratively and independently, and engage in purposeful learning activities.

5.32 The teacher engages students in individual and group learning activities that help them develop the motivation to achieve, by, for example, relating lessons to students' personal interests, allowing students to have choices in their learning, and leading students to ask questions and pursue problems that are meaningful to them.

5.33 The teacher organizes, allocates, and manages the resources of time, space, activities, and attention to provide active and equitable engagement of students in productive tasks.

5.34 The teacher maximizes the amount of class time spent in learning by creating expectations and processes for communication and behavior along with a physical setting conducive to classroom goals.

5.35 The teacher helps the group to develop shared values and expectations for student interactions, academic discussions, and individual and group responsibility that create a positive classroom climate of openness, mutual respect, support, and inquiry.

5.36 The teacher analyzes the classroom environment and makes decisions and adjustments to enhance social relationships, student motivation and engagement, and productive work.

5.37 The teacher organizes, prepares students for, and monitors independent and group work that allows for full and varied participation of all individuals.

Standard 6, Communication
The teacher uses knowledge of effective verbal, nonverbal, and media communication techniques to foster active inquiry, collaboration, and supportive interaction in the classroom.

6.10 Knowledge
6.11 The teacher understands communication theory, language development, and the role of language in learning.

6.12 The teacher understands how cultural and gender differences can affect communication in the classroom.

6.13 The teacher recognizes the importance of nonverbal as well as verbal communication.

6.14 The teacher knows about and can use effective verbal, nonverbal, and media communication techniques.

6.20 Dispositions
6.21 The teacher recognizes the power of language for fostering self-expression, identity development, and learning.
6.22 The teacher values many ways in which people seek to communicate and encourages many modes of communication in the classroom.

6.23 The teacher is a thoughtful and responsive listener.

6.24 The teacher appreciates the cultural dimensions of communication, responds appropriately, and seeks to foster culturally sensitive communication by and among all students in the class.

6.30 Performance
6.31 The teacher models effective communications strategies in conveying ideas and information and in asking questions (e.g. monitoring the effects of messages, restating ideas and drawing connections, using visual, aural, and kinesthetic cues, being sensitive to nonverbal cues given and received).

6.32 The teacher supports and expands learner expression in speaking, writing, and other media.

6.33 The teacher knows how to ask questions and stimulate discussion in different ways for particular purposes, for example, probing for learner understanding, helping students articulate their ideas and thinking processes, promoting risk-taking and problem-solving, facilitating factual recall, encouraging convergent and divergent thinking, stimulating curiosity, helping stimulate students to question.

6.34 The teacher communicates in ways that demonstrate a sensitivity to cultural and gender differences (e.g. appropriate use of eye contact, interpretation of body language and verbal statements, acknowledgment of and responsiveness to different modes of communication and participation).

6.35 The teacher knows how to use a variety of media communication tools, including audio-visual aids and computers, including educational technology, to enrich learning opportunities.

Standard 9: Reflection and Professional Development: The teacher is a reflective practitioner who continually evaluates the effects of her/his choices and actions on others (students, parents, and other professionals in the learning community) and who actively seeks out opportunities to grow professionally

9.10 Knowledge
9.11 The teacher understands the historical and philosophical foundations of education.

9.12 The teacher understands methods of inquiry that provide him/her with a variety of self-assessment and problem solving strategies for reflecting on his/her practice, its influences on students' growth and learning, and the complex interactions between them.

9.13 The teacher is aware of major areas of research on teaching and of resources available for professional learning (e.g. professional literature, colleagues, professional associations, professional development activities).

9.20 Dispositions
9.21 The teacher values critical thinking and self-directed learning as habits of mind.

9.22 The teacher is committed to reflection, assessment, and learning as an ongoing process.

9.23 The teacher is willing to give and receive help.

9.24 The teacher is committed to seeking out, developing, and continually refining practices that address the individual needs of students.
9.25 The teacher recognizes her/his professional responsibility for engaging in and supporting appropriate professional practices for self and colleagues.

9.30 Performance
9.31 The teacher uses classroom observation, information about students, and research as sources for evaluating the outcomes of teaching and learning and as a basis for experimenting with, reflecting on, and revising practice.

9.32 The teacher seeks out professional literature, colleagues, and other resources to support her/his own development as a learner and a teacher.

9.33 The teacher draws upon professional colleagues within the school and other professional arenas as supports for reflection, problem-solving and new ideas, actively sharing experiences and seeking and giving feedback.

10.10 Knowledge
10.11 The teacher understands schools as organizations within the larger community context and understands the operations of the relevant aspects of the system(s) within s/he works.
10.12 The teacher understands how factors in the students' environment outside of school (e.g. family circumstances, community environments, health and economic conditions) may influence students' life and learning.

10.13 The teacher understands and implements laws related to student's rights and teacher responsibilities (e.g. for equal education, appropriate education for students with disabilities, confidentiality, privacy, appropriate treatment of students, reporting in situations related to possible child abuse).

10.20 Dispositions
10.21 The teacher values and appreciates the importance of all aspects of a child's experience.

10.22 The teacher is concerned about all aspects of child's well-being (cognitive, emotional, social, and physical), and is alert to signs of difficulties.

10.23 The teacher respects the privacy of students and confidentiality of information.

10.24 The teacher is willing to consult with other adults regarding the education and well-being of her/his students.

10.25 The teacher is willing to work with other professionals to improve the overall learning environment for students.

10.30 Performances
10.31 The teacher participates in collegial activities designed to make the entire school a productive learning environment.

10.32 The teacher makes links with the learners' other environments on behalf of students, by consulting with parents, counselors, teachers of other classes and activities within the schools, and professionals in other community agencies.

10.33 The teacher can identify and use community resources to foster student learning.
10.34 The teacher establishes respectful and productive relationships with parents and guardians from diverse home and community situations, and seeks to develop cooperative partnerships in support of student learning and well being.

10.35 The teacher talks with and listens to the student, is sensitive and responsive to clues of distress, investigates situations, and seeks outside help as needed and appropriate to remedy problems.

10.36 The teacher acts as an advocate for students.

**Florida Educator Accomplished Practices (FEAP)**

**Accomplished Practice #2: COMMUNICATION**

2.1 The preprofessional teacher recognizes the need for effective communication in the classroom and is in the process of acquiring techniques which she/he will use in the classroom.

2.2 STANDARD: Communication -- Uses effective communication techniques with students and all other stakeholders.

2.a Establishes positive interactions in the learning environment that uses incentives and consequences for students.

2.b Establishes positive interactions between the teacher and student that are focused upon learning.

2.c Varies communication (both verbal and nonverbal) according to the nature and needs of individuals.

2.d Encourages students in a positive and supportive manner.

2.e Communicates to all students high expectations for learning.

2.h Practices strategies that support individual and group inquiry.

2.j Identifies communication techniques for use with colleagues, school/community specialists, administrators, and families, including families whose home language is not English.

**Accomplished Practice #4: Critical-thinking**

4.1 The pre-professional teacher is acquiring performance assessment techniques and strategies that measure higher order thinking skills in students and is building a repertoire of realistic projects and problem-solving activities designed to assist all students in demonstrating their ability to think creatively. (A) Uses appropriate techniques and strategies which promote and enhance critical, creative, and evaluative thinking capabilities of students.

1. Uses assessment strategies (traditional and alternate) to assist the continuous development of the learner. ASSESSMENT

4.2. Uses appropriate techniques and strategies which promote and enhance critical, creative, and evaluative thinking capabilities of students.

4.a Provides opportunities for students to learn higher-order thinking skills.

4.b Identifies strategies, materials, and technologies that she/he will use to expand students’ thinking abilities.

4.g Demonstrates and models the use of higher-order thinking abilities.

**Accomplished Practice #7: HUMAN DEVELOPMENT AND LEARNING**

7.1 Drawing upon well established human development/learning theories and concepts and a variety of information about students, the preprofessional teacher plans instructional activities.

7.a Recognizes developmental levels of students and identifies differences within a group of students.

7.d Communicates with students effectively by taking into account their developmental levels, linguistic development, cultural heritage, experiential background, and interests.

7.e Varies activities to accommodate different student learning needs, developmental levels, experiential backgrounds, linguistic development, and cultural heritage.

7.h Develops short-term personal and professional goals relating to human development and learning.
Accomplished Practice #8: KNOWLEDGE OF SUBJECT MATTER
8.2 Demonstrates knowledge and understanding of the subject matter.
8.b Increases subject matter knowledge in order to integrate the learning activities.
8.f Develops short- and long-term personal and professional goals relating to knowledge of subject matter.

Accomplished Practice #11: ROLE OF THE TEACHER
11.1 The preprofessional teacher communicates and works cooperatively with families and colleagues to improve the educational experiences at the school.
11.2 STANDARD: Role of the Teacher -- Works with various education professionals, parents, and other stakeholders in the continuous improvement of the educational experiences of students.
11.b Provides meaningful feedback on student progress to students and families and seeks assistance for self and families.

Accomplished Practice #12: TECHNOLOGY
12.b Uses technology tools on a personal basis.
12.c Demonstrates awareness of and models acceptable use policies and copyright issues.
12.d Identifies and uses standard references in electronic media.
12.i Selects and utilizes educational software tools for instructional purposes based upon reviews and recommendations of other professionals.
12.j Uses digital information obtained through intranets and/or the Internet (e.g., e-mail and research).
12.k Uses technology to collaborate with others.
12.l Develops professional goals relating to technology integration.

National Science Teachers Association Standards (NSTA)

Standard 1: Content

Teachers of science understand and can articulate the knowledge and practices of contemporary science. They can interrelate and interpret important concepts, ideas, and applications in their fields of licensure; and can conduct scientific investigations. To show that they are prepared in content, teachers of science must demonstrate that they:

a. Understand and can successfully convey to students the major concepts, principles, theories, laws, and interrelationships of their fields of licensure and supporting fields as recommended by the National Science Teachers Association.
b. Understand and can successfully convey to students the unifying concepts of science delineated by the National Science Education Standards.
c. Understand and can successfully convey to students important personal and technological applications of science in their fields of licensure.
d. Understand research and can successfully design, conduct, report and evaluate investigations in science.
e. Understand and can successfully use mathematics to process and report data, and solve problems, in their field(s) of licensure.

B.2. In relation to the physical sciences, science specialists at this level should have all of the competencies described for the elementary generalist, but also should be prepared in chemistry and physics to lead students to understand:
15. Classifications of elements and compounds.
16. Solvents (especially water) and solutions.

B.4. To create interdisciplinary perspectives and to help students understand why science is important to them, elementary/middle level science specialists should have all of the competencies described for the elementary generalist, but also should be prepared to lead students to understand:

33. Use of technological tools in science, including calculators and computers.

C.3. Recommendations for Teachers of Chemistry

C.3.a. Core Competencies. All teachers of chemistry should be prepared lead students to understand the unifying concepts required of all teachers of science, and should in addition be prepared to lead students to understand:
1. Fundamental structures of atoms and molecules.
3. Physical and chemical properties and classification of elements including periodicity.

C.3.b. Advanced Competencies. In addition to the core competencies, teachers of chemistry as a primary field should also be prepared to effectively lead students to understand:
20. Solvent system concepts including non-aqueous solvents.
27. Applications of chemistry and chemical technology in society, business, industry, and health fields. (CHM 4930)

Standard 10: Professional Growth
Teachers of science strive continuously to grow and change, personally and professionally, to meet the diverse needs of their students, school, community, and profession. They have a desire and disposition for growth and betterment. To show their disposition for growth, teachers of science must demonstrate that they:

a. Engage actively and continuously in opportunities for professional learning and leadership that reach beyond minimum job requirements.
b. Reflect constantly upon their teaching and identify ways and means through which they may grow professionally.
c. Use information from students, supervisors, colleagues and others to improve their teaching and facilitate their professional growth.

Professional Organization/Learned Society Standards
National Society of Science Teachers Association
Florida Teacher Certification Examination (FTCE) Subject Area Examination (SAE) Competencies and Skills
**Professional Society / National and State Standards Addressed in the Course**

**American Chemical Society (ACS) Expected Outcomes:**
This course should ensure that students know basic chemical concepts such as stoichiometry, states of matter, atomic structure, molecular structure and bonding, thermodynamics, equilibria, and kinetics. Students need to be competent in basic laboratory skills such as safe practices, keeping a notebook, use of electronic balances and volumetric glassware, preparation of solutions, chemical measurements using pH electrodes and spectrophotometers, data analysis, and report writing.

**Course Artifacts**

<table>
<thead>
<tr>
<th>Standards</th>
<th>Name of the Artifact 1</th>
<th>Name of the Artifact 2</th>
<th>Name of the Artifact 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEU CF</td>
<td>1.5, 2.1, 2.5, 2.7, 3.4, 3.5, 4.3, 4.5, 5.1</td>
<td>1.5, 2.1, 2.5, 2.7, 3.4, 3.5, 4.3, 4.5, 5.1</td>
<td>1.5, 2.1, 2.5, 2.7, 3.4, 3.5, 4.3, 4.5, 5.1</td>
</tr>
<tr>
<td>FEAPS</td>
<td>2.1, 2.2, 2.a, 2.b, 2.c, 2.e, 2.h, 2.j, 2.k, 4.1, 4.2, 4.a, 4.b, 4.g, 8.2, 8.a, 8.b, 8.f, 11.1, 11.2, 11.b, 12.b, 12.c, 12.i, 12.j, 12.l.</td>
<td>2.1, 2.2, 2.a, 2.b, 2.c, 2.e, 2.h, 2.j, 2.k, 4.1, 4.2, 4.a, 4.b, 4.g, 8.2, 8.a, 8.b, 8.f, 11.1, 11.2, 11.b, 12.b, 12.c, 12.i, 12.j, 12.l.</td>
<td>2.1, 2.2, 2.a, 2.b, 2.c, 2.e, 2.h, 2.j, 2.k, 4.1, 4.2, 4.a, 4.b, 4.g, 8.2, 8.a, 8.b, 8.f, 11.1, 11.2, 11.b, 12.b, 12.c, 12.i, 12.j, 12.l.</td>
</tr>
<tr>
<td>INTASC</td>
<td>1, 4, 5, 6, 9, 10,</td>
<td>1, 4, 5, 6, 9, 10</td>
<td>1, 4, 5, 6, 9, 10</td>
</tr>
<tr>
<td>FTCE</td>
<td>1.6, 1.7, 1.8, 3.12, 3.13, 4.3, 4.5, 4.6, 4.7</td>
<td>1.3, 1.4, 1.8, 3.2, 3.3</td>
<td>4.15, 4.16, 6.7, 6.8, 6.9</td>
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</tbody>
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Rubric for evaluation (for all artifacts):

4 points - Calculations are correct and results are accurate.
3 points - Calculations are correct and accuracy is fair.
2 points - Calculations are correct but lack accuracy.
1 point - Calculations are partly correct but lack accuracy.

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Behavioral Objectives</th>
<th>INTASC Standards</th>
<th>FTCE SAE</th>
<th>FEAPS</th>
<th>NSTA</th>
<th>PEU Conceptual Framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework: Selected analytical chemistry problems from the textbook and additional instructor addendums</td>
<td>Students will 1. Demonstrate knowledge of the lecture material, and 2. Develop and enhance the skill of analytical analysis and problem solving</td>
<td>1, 4, 5, 6, 9, 10</td>
<td>1.6, 1.7, 1.8, 3.12, 3.13, 4.3, 4.5, 4.6, 4.7, 1.3, 1.4, 3.2, 3.3, 4.13, 4.14, 4.20, 4.15, 4.16, 6.2, 6.3, 6.4, 6.5</td>
<td>2.4, 7, 8, 11, 12</td>
<td>1; 1.B.2.15, 16; 1.B.4.33; 1.C.3.a.1, 3; 1.C.3.b.20, 27.; 10.a, 10.b, 10.c.</td>
<td>1.5, 2.1, 2.5, 2.7, 3.4, 3.5, 4.3, 4.5, 5.1</td>
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<tr>
<td>Each homework assignment will address course content and is aimed at development of problem solving skills.</td>
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<tr>
<td>Quizzes</td>
<td>Selected analytical chemistry problems from the textbook and additional instructor addendums Each homework assignment will address course content and is aimed at development of problem solving skills.</td>
<td>Develop critical thinking and written communication skills</td>
<td>1, 4, 5, 6, 9, 10</td>
<td>1.6, 1.7, 1.8, 3.12, 3.13, 4.3, 4.5, 4.6, 4.7 1.3, 1.4, 3.2, 3.3, 4.13, 4.14, 4.20 4.15, 4.16, 6.2, 6.3, 6.4, 6.5</td>
<td>2, 4, 7, 8, 11, 12</td>
<td>1; 1.B.2.15, 16; 1.B.4.33; 1.C.3.a.1, 3; 1.C.3.b.20, 27; 10.a, 10.b, 10.c.</td>
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</tbody>
</table>

| Exams: | Three one-hour tests, each test covering specific chapters. Final exam is comprehensive and will cover all the materials in the semester | Develop critical thinking and written communication skills | 1, 4, 5, 6, 9, 10 | 1.6, 1.7, 1.8, 3.12, 3.13, 4.3, 4.5, 4.6, 4.7 1.3, 1.4, 3.2, 3.3, 4.13, 4.14, 4.20 4.15, 4.16, 6.2, 6.3, 6.4, 6.5 | 2, 4, 7, 8, 11, 12 | 1; 1.B.2.15, 16; 1.B.4.33; 1.C.3.a.1, 3; 1.C.3.b.20, 27; 10.a, 10.b, 10.c. | 1.5, 2.1, 2.5, 2.7, 3.4, 3.5, 4.3, 4.5, 5.1 |

**Overall Goals of the Course**

This is a specialized course designed for chemistry majors. It covers classical methods for analysis as well as modern analytical instrumentation. The basic chemistry concepts are developing for the specific needs of the analytical methods. Topics, such as chemical equilibrium, kinetics, interaction of light with matter, will be studied in terms of their application in quantitative analysis.

**Specific Behavioral Objectives**

**Chapter 1: Analytical Objectives, or What Analytical Chemists Do. (Standards addressed in this chapter: FTCE 4.1, 6.1, 6.2, 6.5, 6.6, 6.7, 6.8, 6.9, ACS)**

1. Understand the nature and the objectives of the analytical science.
2. Be able to explain the steps in a typical chemical analysis.
3. Describe the sampling process and the sample preparation.
4. Be able to perform analytical calibration.
5. Be able to calculate and present the results from a chemical analysis.

**Chapter 2: Basic Tools and Operations of Analytical Chemistry. (Standards addressed in this chapter: FTCE 3.12, 3.13, 4.1, 4.2, 5.1, 5.2, ACS)**

1. Learn how to properly record experimental data in a laboratory notebook.
2. Know how to use and handle laboratory materials and reagents.
3. Be able to deliver liquids using volumetric glassware.
4. Learn how to weigh different objects using an analytical balance.
5. Understand the calibration of volumetric glassware.
Chapter 3: Data Handling and Spreadsheets in Analytical Chemistry. (Standards addressed in this chapter: FTCE 6.3, 6.4, 7.4, 7.5, ACS)
1. Define accuracy and precision.
2. Understand the difference between systematic and random errors.
3. Be able to properly use significant figures in algebraic operations.
4. Describe absolute errors and their relationship to accuracy.
5. Use spreadsheets for analytical calculations.
6. Understand the propagation of errors and be able to calculate a confidence interval.
7. Learn how to retain or reject analytical data (Q-test).

Chapter 4: Good Laboratory Practice: Quality Assurance of Analytical Measurements. (Standards addressed in this chapter: FTCE 6.3, 6.4, 6.5, 6.6, 6.7, ACS)
1. Understand the principles of the good laboratory practice.
2. Be able to perform validation of an analytical method.
3. Learn the basics of the quality assurance procedure.

Chapter 24: Clinical Chemistry. (Standards addressed in this chapter: FTCE 1.3, 1.4, 1.5, 3.1, ACS)
1. Use your knowledge about blood composition to explain the most common laboratory blood analyses.
2. Explain the blood sample collection and preservation from an analytical viewpoint.
3. Understand the principles of the immunoassay analysis.

Chapter 5: Stoichiometric calculations: The Workhorse of the Analysis. (Standards addressed in this chapter: FTCE 1.6, 1.7, 1.8, 3.12, 3.13, 4.3, 4.5, 4.6, 4.7, ACS)
1. Use properly atomic and molecular weights in calculations.
2. Be able to perform calculations using molarity, molality, percent concentration, ppm, ppb etc.
3. Understand the difference between analytical and equilibrium concentration.
4. Be able to properly present analytical results.
5. Define normality and titer.

Chapter 6: General Concepts of Chemical Equilibrium. (Standards addressed in this chapter: FTCE 4.9, 4.11, 5.3, 5.4, 5.5, ACS)
1. Understand the concept of the rate of a chemical reaction.
2. Be able to apply LeChatelier's principle in solving analytical problems.
3. Be able to apply the equilibrium constant concept in cases of weak electrolytes and precipitates.
4. Know how to use spreadsheets for solving equilibrium problems.
5. Apply activity, activity coefficients and ionic strength for calculation of a thermodynamic equilibrium constant.

Chapter 7: Acid-base equilibria. (Standards addressed in this chapter: FTCE 1.3, 1.4, 1.8, 3.2, 3.3, ACS)
1. Be familiar with the different acid-base theories.
2. Understand the pH scale and pH temperature dependence.
3. Calculate pH of weak acids, bases and buffers.
5. Understand the function of physiological buffers.

Chapter 8: Acid-Base Titrations. (Standards addressed in this chapter: FTCE 4.9, 4.11, 4.15, 4.16, 7.5, ACS).
1. Learn how to perform different types of titrations.
2. Apply spreadsheets to construct a titration curve.
3. Be able to build a titration curve for titration of a polyprotic acid.

**Chapter 9: Complexation Reactions and Titrations. (Standards addressed in this chapter: FTCE 2.8, 2.9, 2.10, 5.6, ACS).**
1. Understand the complexation process and the complex stability.
2. Apply the concept of a chelate formation for complexometric titration.
3. Understand how to use complexes for metal ion determination.
4. Be able to successfully perform complexometric calculations.

**Chapter 10: Gravimetric Analysis and Precipitation Equilibria. (Standards addressed in this chapter: FTCE 1.3, 1.4, 1.5, 4.1, 4.9, 4.11, 4.15, 5.3).**
1. Learn the principles and techniques of a successful gravimetric analysis.
2. Know the theory of the analytical precipitation.
3. Be able to perform gravimetric calculations as well as statistical analysis of the data.

**Chapter 13: Potentiometric Electrodes and Potentiometry. (Standards addressed in this chapter: FTCE 4.9, 4.15, 4.16, 6.7, 6.8, 7.5).**
1. Know the principles of operation of a metal electrode.
2. Understand the principle of operation of a voltaic cell.
3. Be able to describe the operation of a standard calomel electrode.
4. Describe the function of a glass electrode.
5. Define an ion-selective electrode.

**Chapter 18: Sample Preparation: Solvent and Solid-Phase Extraction. (Standards addressed in this chapter: FTCE 1.7, 1.8, 2.9, 6.3, 6.4, ACS).**
1. Define distribution coefficient, distribution ratio, percent extraction.
2. Learn the theory of a metal ion extraction.
3. Explain the basics of a solid-phase extraction.
4. Know the most common phases for solid state extraction.

**Chapter 19: Chromatography: Principles and Theory. (Standards addressed in this chapter: FTCE 4.15, 4.16, 6.7, 6.8, 6.9, ACS).**
1. Understand the theory and the principles of the chromatographic separations.
2. Know the basic classification of the chromatography techniques.
3. Be able to calculate the number of theoretical plates for a given column.
4. Explain the meaning of the parameters in VanDeemter's equation.
5. Calculate column resolution.

**Florida Teacher Certification Examination (FTCE) Subject Area Examination (SAE) Competencies and Skills**

1. **Knowledge of the nature of matter**
   1. Differentiate between pure substances, homogeneous mixtures, and heterogeneous mixtures.
   2. Determine the effects of changes in temperature, volume, pressure, or quantity on an ideal gas.
   3. Apply units of mass, volume, and moles to determine concentrations and dilutions of solutions.
   4. Analyze the effects of physical conditions on solubility and the dissolving process.
5. Evaluate problems relating colligative properties, molar mass, and solution concentrations.
6. Analyze the effects of forces between chemical species on properties (e.g., melting point, boiling point, vapor pressure, solubility, conductivity) of matter.
7. Solve problems involving an intensive property (e.g., density, specific heat) of matter.
8. Differentiate physical methods (e.g., chromatography, filtration, extraction) for separating the components of mixtures.

2. **Knowledge of energy and its interaction with matter**
   1. Distinguish between different forms of energy (e.g., thermal, electrical, nuclear).
   2. Relate temperature and heat to kinetic molecular theory.
   3. Interpret a phase diagram of a pure substance.
   4. Interpret a heating/cooling curve of a substance.
   5. Calculate thermal changes in chemical reactions, such as heats of reaction, heats of formation, and/or heats of combustion, from data.
   6. Analyze entropy changes during solution formation, phase changes, and chemical reactions.
   7. Predict spontaneity of a chemical process given initial and final values of free energy, temperature, enthalpy, and/or entropy.
   8. Relate regions of the electromagnetic spectrum to the energy, wavelength, and frequency of photons.
   9. Relate regions of the electromagnetic spectrum to their effect on chemical or physical properties of matter.
   10. Analyze energy transformations in physical and biological systems (e.g., energy from the Sun to electricity, from food consumption to physical activity).

3. **Knowledge of bonding and molecular structure**
   1. Identify the basic theory and applications of spectroscopy (e.g., MRI, x-ray, mass spectrometry, UV, microwave, NMR, IR).
   2. Identify types and examples of metallic, ionic, and covalent (polar and nonpolar) bonds.
   3. Apply electronegativity to bond type.
   4. Identify characteristics of simple organic compounds.
   5. Given the structural formula for a simple organic compound, identify the hybridization of the atoms.
   6. Identify sigma and pi bonds in a compound.
   7. Interpret the information derived from the following models: Lewis electron dot structures, valence shell electron pair repulsion (VSEPR) theory, and molecular orbital (M/O) theory.
   8. Select the most probable Lewis electron dot structure for an ionic or covalent formula (e.g., CO₂, Na₂CO₃) that follows the octet rule.
   9. Predict geometry of simple molecules (e.g., symmetry elements).
   10. Predict polarity of simple compounds.
   11. Predict physical or chemical properties based upon the type of bonding involved.
   12. Identify an inorganic chemical formula (ionic or molecular), given the name.
   13. Select the name of an inorganic chemical compound (ionic or molecular), given its formula.
   14. Identify properly named formulas for simple organic compounds.
   15. Identify common organic functional groups.
16. Differentiate between the structures of common biochemical compounds, such as lipids, amino acids, carbohydrates, and nucleic acids.

4. **Knowledge of chemical reactions and stoichiometry**
   1. Balance chemical equations.
   2. Given common chemical species and reaction conditions, predict probable reaction products.
   3. Solve mass-mass stoichiometry problems.
   5. Solve solution stoichiometry problems.
   7. Determine empirical formulas from experimental data.
   8. Analyze the effects of concentration, temperature, pressure, surface area, and the presence or absence of catalysts on the rates of reaction.
   9. Assess the effects of changes in concentration, temperature, or pressure on a state of a system initially at equilibrium (Le Chatelier's principle).
   10. Determine rate laws from concentration and rate data.
   11. Calculate either the equilibrium constant or concentration of a reaction species at equilibrium (e.g., \( K_a \), \( K_b \), \( K_{sp} \), \( K_w \), \( K_{eq} \)).
   12. Identify the characteristics of a chemical system in dynamic equilibrium.
   13. Identify major characteristics of strong and weak acids or bases.
   14. Evaluate the properties of buffer systems.
   15. Interpret graphical and numerical titration data.
   17. Balance incomplete redox equations in acidic and basic solutions.
   18. Determine the spontaneity of a chemical reaction using standard reduction potentials.
   19. Identify the characteristics of biochemical and fossil fuel combustion reactions.
   20. Solve problems related to pH of strong acids or bases.
   21. Analyze electrolytic and/or voltaic cells.

5. **Knowledge of atomic theory and structure**
   1. Using the periodic table, determine the number of protons, neutrons, and electrons in a specific isotope of an atom or ion.
   2. Using the periodic table, relate the physical properties of atoms and ions to the elements' positions on the table.
   3. Using the periodic table, relate the chemical reactivity of elements to their positions on the table.
   4. Using the periodic table, determine electron configurations for main group and transition elements.
   5. Relate chemical activity to electron configuration.
   6. Identify characteristics of the wave and particle nature of matter.
   7. Identify characteristics of unstable nuclei and the particles and energies emitted.
   8. Given measurable quantities, calculate parameters of radioactive decay.
   10. Analyze the processes of nuclear fission and fusion, including interconversion of mass and energy.
   11. Identify electron density distribution diagrams and characteristics for s, p, and d orbitals (e.g., nodes).

6. **Knowledge of the nature of science**
   1. Identify the characteristics and components of scientific inquiry.
2. Identify how the characteristics of scientific research differ from those of other areas of learning.
3. Identify variables in a given experimental design.
4. Identify bias in an experimental design.
5. Evaluate, interpret, and predict from empirical data.
6. Interpret graphical data.
7. Analyze the relationship between experimental observations and underlying assumptions, hypotheses, conclusions, laws, or theories.
8. Relate experimental evidence to models.
9. Differentiate between the uses of qualitative and quantitative data.
10. Analyze the relationship between basic scientific research and applied research, technology, the economy, or the public good.
11. Identify how science and society influence each other.
12. Identify evidence of the progressive development of science.

7. Knowledge of measurement
   1. Convert between dimensional units for 1, 2, and 3 dimensional measurements.
   2. Analyze the dimensional units of a mathematical formula.
   3. Identify prefixes (e.g., kilo-, milli-, nano-) used in scientific measurements.
   4. Distinguish between accuracy and precision and between systematic and random error.
   5. Apply the correct number of significant figures in measurements or calculations.
   6. Relate the Celsius, Fahrenheit, and Kelvin temperature scales as they pertain to the physical properties of water.
   7. Convert between different units of energy.

8. Knowledge of appropriate laboratory use and procedures
   1. Identify appropriate chemistry laboratory procedures for the safe storage, use, and disposal of materials and equipment.
   2. Choose the correct laboratory equipment for a particular procedure.
   3. Identify emergency procedures and safety equipment needed in the science laboratory and classroom.
   4. Identify the areas of teacher liability and responsibility in science-related activities.
   5. Demonstrate knowledge of pertinent legislation and national guidelines regarding laboratory safety, hazardous materials, experimentation, and accommodations for special needs students (e.g., American Chemical Society, National Science Teachers Association).

**Topical Outline**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Chapter</th>
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<td>Analytical Objectives, or: What Analytical Chemists Do.</td>
<td>1</td>
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<tr>
<td>Basic Tools and Operations of Analytical Chemistry</td>
<td>2</td>
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<tr>
<td>Data Handling and Spreadsheets in Analytical Chemistry</td>
<td>3</td>
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<tr>
<td>Good Laboratory Practice: Quality Assurance of Analytical Measurements</td>
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<tr>
<td>Clinical Chemistry</td>
<td>24</td>
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<tr>
<td>Stoichiometric Calculations: The Workhorse of the Analyst</td>
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<tr>
<td>General Concepts of Chemical Equilibrium</td>
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<tr>
<td>Acid-Base Equilibria</td>
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Complexiometric Reactions and Titrations 9
Gravimetric Analysis and Precipitation Equilibria 10
Potentiometric Electrodes and Potentiometry 13
Sample Preparation: Solvent and Solid-Phase Extraction 18
Chromatography: Principles and Theory 19

Teaching Methodology

Lecture Style, Use of Overheads, and PowerPoint, Web-Based Instruction (Course Compass, Blackboard, etc.)

Course Evaluation

Written Quizzes and Exams, Science Paper Analysis, Homework.

Grading

Quizzes will be given during lecture time. Homework assignments include spreadsheets exercises, graphing data and solving analytical problems using different calibration methods as well as computational problems and literature search. You will be required also to read and analyze several contemporary science papers and to submit the analysis in a written worm.

Testing and Evaluation

The final grade for this class will be based on the following:

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<tr>
<td>Three Hour Exams, 100 points each</td>
<td>300 points</td>
</tr>
<tr>
<td>Final Exam, 150 points</td>
<td>150 points</td>
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<tr>
<td>Quizzes, (10 best of 11), 15 points each</td>
<td>150 points</td>
</tr>
<tr>
<td>Science Paper Analysis and Homework Assignments</td>
<td>100 points</td>
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<tr>
<td>Total:</td>
<td>700 points</td>
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Course Schedule

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<th>WEEK OF</th>
<th>CHAPTER</th>
<th>SUBJECT</th>
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<td>Analytical Objectives, or: What Analytical Chemists Do.</td>
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<td>Chapter 3</td>
<td>Data Handling and Spreadsheets in Analytical Chemistry.</td>
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<tr>
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<td></td>
<td>Quiz 1</td>
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<tr>
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<td>Homework 1 due on Sept. 3 in class.</td>
</tr>
<tr>
<td>Sept. 8, 2008</td>
<td>Chapters 3- cont.</td>
<td>Data Handling and Spreadsheets in Analytical Chemistry.</td>
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<tr>
<td></td>
<td>Chapter 4</td>
<td>Good Laboratory Practice of Analytical Measurements.</td>
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<td>Quiz 2</td>
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<td>Homework 2 due on Sept. 10 in class.</td>
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<tr>
<td>Sept. 15, 2008</td>
<td>Chapter 4-cont.</td>
<td>Good Laboratory Practice of Analytical Measurements.</td>
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<tr>
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<td>Chapter 24</td>
<td>Clinical Chemistry</td>
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<tr>
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<td></td>
<td>Quiz 3</td>
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<tr>
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<td></td>
<td>Paper 1 Analysis due on Sept. 17, in class.</td>
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<td></td>
<td>Chapter 6</td>
<td>General Concepts of Chemical Equilibrium.</td>
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<tr>
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<td>Quiz 4</td>
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<td>Homework 4 due on Oct. 2 in class.</td>
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Exam #1: Monday, Sept. 22, 2008  Chapters 1-4, 24
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<th>Topic</th>
<th>Quiz Due</th>
<th>Homework Due</th>
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<tbody>
<tr>
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<td>Quiz 5</td>
<td>Homework 5 due on Oct. 8 in class</td>
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<td>Oct. 13, 2008</td>
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<td>Acid-Base Equilibria</td>
<td>Quiz 6</td>
<td>Homework 6 due on Oct. 15, in class</td>
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<td>Oct. 20, 2008</td>
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<td>Acid-Base Titrations</td>
<td>Quiz 7</td>
<td>Homework 7 due on Oct. 22, in class</td>
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<td>Oct. 27, 2008</td>
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<td>Complexometric Reactions and Titrations</td>
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Exam #2: Monday, Oct. 27, 2008 Chapters 5-8

<table>
<thead>
<tr>
<th>Date</th>
<th>Chapter</th>
<th>Topic</th>
<th>Quiz Due</th>
<th>Homework Due</th>
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<tbody>
<tr>
<td>Nov. 3, 2008</td>
<td>9 - cont.</td>
<td>Complexometric Reactions and Titrations</td>
<td>Quiz 8</td>
<td>Homework 8 due on Nov. 5, in class</td>
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<td>Nov. 10, 2008</td>
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<td>Gravimetric Analysis and Precipitation</td>
<td>Quiz 9</td>
<td>Homework 9 due on Nov. 12, in class</td>
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</table>

Nov. 11, 2008 Veterans Day No Classes

<table>
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<tr>
<th>Date</th>
<th>Chapter</th>
<th>Topic</th>
<th>Quiz Due</th>
<th>Homework Due</th>
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<tbody>
<tr>
<td>Nov. 17, 2008</td>
<td>13</td>
<td>Potentiometric Electrods and Potentiometry</td>
<td>Quiz 10</td>
<td>Paper 2 analysis due on Nov. 19, in class</td>
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<td>Nov. 24, 2008</td>
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<td>Sample Preparation: Solvent and Solid-Phase Extraction</td>
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Nov. 27-28 Thanksgiving Holiday, No Classes

Exam #3: Monday, Dec. 3, 2008 Chapters 9, 10, 13, 18, 19

Final Exam: Week of Dec. 8, 2008 TBA

Course Policies

NO MAKE-UP EXAMS OR QUIZZES WILL BE GIVEN
Compensation for missed exams because of extreme circumstances will be discussed individually. A student must present a written excuse from the Dean of the School of Arts and Sciences in order to be considered for compensation.

**Academic Learning Compacts (ALCs):** The Chemistry curriculum is in compliance with ALCs. ALCs answer three basic questions: What will students learn by the end of their academic programs? Have they learned what they have been taught by their professors? How do we measure these quantities? For details please follow the link below:


**Attendance Policy:** ATTENDANCE IS TAKEN DURING EACH CLASS MEETING. IT IS YOUR RESPONSIBILITY TO WRITE YOUR SIGNATURE NEXT TO YOUR NAME ON THE DAILY ROLL SHEET. IF YOU FAIL TO DO THIS, YOU ARE ABSENT—No exceptions. TWO (2) UNEXCUSED ABSENCES FOR THE CLASS RESULT IN A LOWERING OF YOUR GRADE. A STUDENT EXCEEDING THE NUMBER OF UNEXCUSED ABSENCES MAY BE DROPPED FROM THE COURSE AND ASSIGNED THE GRADE OF “F.” STUDENTS MAY BE READMITTED TO THE CLASS WITH THE DEAN’S AND THE INSTRUCTOR’S PERMISSION. These regulations are fully given on page 31 of the 2006-2008 General Catalog.

**Final Exam:** The final examination will cover all topics in CHM 3120. The exam is combination of multiple choice, written problems, calculations and short answers.

**Students with Disabilities:** Students with disabilities that fall under the Americans with Disabilities Act should follow the following procedures: 1) Provide documentation of your disability to the FAMU student disability resource center; 2) During the first week of class, provide your instructor with a statement from the FAMU student disability resource center indicating that you have registered with FAMU student disability services. The statement should indicate the disability and the special accommodations that will be required.

**Academic Honesty:** It is your responsibility to know the university’s policy on academic/intellectual dishonesty (Section 6C3-2.012(10)(s) of the FAMU Student Handbook). Any student caught cheating in any manner is awarded the grade of F. No warnings are given; it is your responsibility to do your own work. All persons collaborating in cheating will receive the grade of F.

**Non-discrimination policy statement:** It is the policy of the University to assure that each student is permitted to attend classes in an environment free from any form of discrimination, including race, religion, color, age, handicap, sex, marital status, national origin and veteran status.

**Procedure for Resolving Faculty-Student Conflict:**
- Student first attempts to resolve issue with instructor
- Student submits written notification of problem to chair.
- Chair forwards student letter to instructor.
- Instructor responds in writing to chair.
- Chair meets with instructor and/or student if necessary.