Course Proposals for Chemistry Program Revisions

LSC Use Only No: LSC Action-Date:	UWUCC USE Only No. UWUCC Action-Date: App 4/3/03 Senate Action Date: App 4/29/03
249	02-60f

Curriculum Proposal Cover Sheet - University-Wide Undergraduate Curriculum Committee

Contact Person: **Ronald F. See**	Email Address: **rfsee@iup.edu**
Proposing Department/Unit: **Chemistry**	Phone: **7-4489**

Check all appropriate lines and complete information as requested. Use a separate cover sheet for each course proposal and for each program proposal.

1. Course Proposals (check all that apply)

_____New Course _____Course Prefix Change _____Course Deletion

_X_ Course Revision _X_ Course Number and/or Title Change _X_ Catalog Description Change

CHEM 114 – Basic Inorganic Chemistry	CHEM 114 – Concepts in Chemistry II
Current *Course prefix, number and full title*	***Proposed*** *course prefix, number and full title, if changing*

2. Additional Course Designations: check if appropriate

_X_ This course is also proposed as a Liberal Studies Course.

_____ This course is also proposed as an Honors College Course.

_____ Other: (e.g., Women's Studies, Pan-African)

3. Program Proposals

_____Catalog Description Change _____Program Revision

_____New Degree Program _____Program Title Change _____Other

_____New Minor Program _____New Track

Current ***program name***	***Proposed*** ***program name, if changing***

4. Approvals		**Date**
Dept Curriculum Committee Chair	Ronald F. See	2/3/03
Department Chair	Luiess VanFossen Ramsey	2/5/03
Coll. Curriculum Committee Chair	John D. Eck	2/11/03
College Dean		
Director of Liberal Studies *		
Director of Honors College *		
Provost *		
Additional signatures as appropriate: (include title)		
UWUCC Co-Chairs	Gail S. Sechrist	4/3/03

* where applicable

Part II. 1. New Syllabus of Record

I. Catalog Description

Course Title: Concepts in Chemistry II
Prefix: CHEM
Number: 114
Hours: 3c-3l-4sh
Prerequisites: CHEM 111 or 113
Co-requisites: none
Description: Introductory course for chemistry majors. This course is the second half of a two-semester sequence designed to give students the foundation of knowledge and laboratory techniques required to successfully complete a chemistry degree program. Topics include kinetic-molecular theory of gases, the liquid and solid states, solution theory, kinetics, equilibrium, thermodynamics, acids and bases, and electrochemistry.

II. Objectives: Upon the successful completion of the course, the student will:

1) understand the states of matter and their characteristic properties.
2) understand the kinetic-molecular model for gases and its relationship to observed empirical laws.
3) understand the principles of solution theory and the properties of solutions.
4) be able to apply the basics of chemical kinetics and the rate laws.
5) understand the basics of chemical equilibria and be able to perform quantitative calculations related to the composition of equilibrium systems.
6) understand the characteristics of acids and bases and the principles of weak acid-base equilibria.
7) understand the principles governing spontaneous reactions, including entropy and Gibbs free energy.
8) understand the fundamental qualitative and quantitative aspects of electrochemical cell and their associated oxidation-reduction reactions.
9) be able to apply principles learned in lecture to laboratory experiments, so that they can qualitatively and quantitatively analyze empirical data and explain its significance.
10) be able to use computer applications for data collection, data analysis and the calculation of molecular properties applicable to kinetics and equilibrium problems.

III. **Detailed Course Outline** (allows three hours for exams):

1) Gases (3 hours)
   a) The Gas Laws
   b) Gas law problems, mixtures of gases
   c) Kinetic-Molecular model of gases
2) Solids and Intermolecular Forces (4 hours)
   a) Van der Waals forces and hydrogen bonds
   b) Types of solids
   c) Phase changes
3) Solutions (4 hours)
   a) Expression of concentration
   b) Mole fraction and Raoult's Law
4) Kinetics (5 hours)
   a) Measurement of reaction rate
   b) Method of initial rates

c) First- and second-order rate equations
d) Determination of reaction order from empirical data

5) Equilibrium (5 hours)
   a) Concept of chemical equilibrium
   b) Equilibrium calculations
   c) Le Chatelier's Principle
6) Acid – Base (6 hours)
   a) Physical description of acids and bases
   b) Weak acid and weak base equilibria
   c) Acid-base properties of conjugate salts
   d) Structural effects on acid strength
7) Aqueous Equilibria (5 hours)
   a) Buffers and buffer calculations
   b) Detailed description of acid-base titrations
   c) Equilibria of slightly soluble salts
8) Entropy and Gibbs Free Energy (4 hours)
   a) Concept of entropy
   b) Quantification of entropy
   c) Gibbs Free Energy
   d) Relationship between ΔG and K_{eq}
9) Electrochemistry (3 hours)
   a) Oxidation, reduction and half-reactions
   b) Standard reduction potentials
   c) Non-spontaneous electrochemical reactions

IV. Evaluation Methods:

Exams	3-60 minute exams x 100pts	= 300pts (37.5%)
Quizzes	10-10 minute quizzes x 10pts	= 100pts (12.5%)
Laboratory	Reports (12 x 10 pts) + quizzes (4 x 20 pts)	= 200pts (25%)
Final Exam	120 minute exam x 200pts	= 200pts (25%)

The 60 minute exams will include of a section of multiple choice and/or short-answer questions, and a section of word problems; these problems will account for at least 50% of the value of the exam. The quizzes will be used to reward completion of the homework assignments. Each quiz will consist of a few questions from the homework, with the numbers or compounds changed from the homework question. The laboratory reports are generated by the student, with sections for introduction, observations, data and calculations, data analysis, summary of results, and questions and discussion. Periodic laboratory quizzes will assess understanding of concepts. The final exam will be similar in form to, but twice as long as, the 60-minute exams. The final exam will be cumulative over the entire semester of material.

V. Example Grading Scale

A: $\geq$90% B: 80-89% C: 70-79% D: 60-69% F: <60%

VI. Attendance Policy:

The attendance policy for this course will be consistent with the university undergraduate attendance policy as described in the current catalogue.

VII. Required Textbook(s), Supplemental Books and Readings:

1. *General Chemistry: The Essential Concepts*, Raymond Chang, 3rd ed., McGraw Hill, New York (2002).
2. *Inquiries into Chemistry*, M.R. Abraham and M.J. Pavelich, 3rd ed., Waveland, Prospect Heights, IL (1997).

VIII. Special Resource Requirements:

1. Safety goggles
2. Laboratory notebook

IX. Bibliography:

1. *General Chemistry: The Essential Concepts*, Raymond Chang, 3rd ed., McGraw Hill, New York (2002).
2. *Inquiries into Chemistry*, M.R. Abraham and M.J. Pavelich, 3rd ed., Waveland, Prospect Heights, IL (1997).
3. *Inorganic Chemistry*, J.E. Huheey, E.A. Keiter, R.L. Keiter, 4th ed., Harper Collins, New York (1993).
4. *Chemical Principles*, Steven S. Zumdahl, 3rd ed., Houghton Mifflin, Boston (1998).
5. *Physical Chemistry*, Joseph H. Noggle, 3rd ed., Harper Collins, New York (1996).
6. *Chemical Bonding and Molecular Geometry: from Lewis to Electron Densities*, R.J. Gillespie and P.L.A. Popelier, Oxford U. Press, New York (2001).
7. http://www.princeton.edu/~mcbrown/display/faces.html
8. *Journal of Chemical Education*
9. *Chemical and Engineering News*
10. *Today's Chemist at Work*
11. *Women Changing Science: Voices from a Field in Transition*, Mary Morse, Perseus Publishing: Cambridge, MA, 2001
12. *Nobel Prize Women in Science: Their Lives, Struggles and Momentous Discoveries*, **2nd Ed.** Sharon Bertsch McGrayne. Joseph Henry Press: Washington, DC, 2001
13. *Notable Women in the Physical Sciences: A Biographical Dictionary*, Benjamin F. Shearer and Barbara S. Shearer, Eds., Greenwood Press (1997).
14. *Women in Chemistry and Physics: A Biographical Sourcebook*, Louise S. Grimstein, Rose K. Rose and Miriam H. Rafailovich, Eds., Greenwood Press (1993).
15. *Blacks in Science and Education*, Vivian O. Sammons, Hemisphere Publishers, Washington, D.C. (1989).

Other information:

<u>Laboratory Schedule</u>

1) Introduction; Safety and Check-In
2) Synthesis of Coordination Compounds
3) Spectral Properties of Coordination Compounds
4) Gas Laws
5) Solid-State Structure
6) The Bromination of Acetone
7) Iron (III) Nitrate and Potassium Thiocyanate
8) Acetic Acid
9) Acid and Base Interactions

10) Unknown Weak Acid
11) pH Titration
12) Studies of a Precipitation Reaction
13) Electrolysis Reactions
14) Check-Out and Final Quiz

Part II. 2. Summary of the proposed revisions.

Old Catalog Description: CHEM 114 Basic Inorganic Chemistry (3c-3l-4sh)
Topics include chemical kinetics, equilibrium and thermodynamics, acids and bases, electrochemistry, coordination chemistry, and descriptive chemistry of selected elements.

New Catalog Description: CHEM 114 Concepts in Chemistry II (3c-3l-4sh)
Introductory course for chemistry majors. This course is the second half of a two-semester sequence designed to give students the foundation of knowledge and laboratory techniques required to successfully complete a chemistry degree program. Topics include kinetic-molecular theory of gases, the liquid and solid states, solution theory, kinetics, equilibrium, thermodynamics, acids and bases, and electrochemistry.

CHEM 114 now includes three topics taught in the former CHEM 113 (Gases, Spontaneous Reactions and Gibbs Free Energy, Solids and Intermolecular Forces). One topic (Compounds of the Transition Metals) formerly in CHEM 114 has been moved to CHEM 113. The descriptive inorganic topics from the former CHEM 114 have been moved to a new course, CHEM 214, and the topics that remain have been expanded. The revised laboratory activities reflect the new lecture topics. The title change results from the reorganization of the topics, particularly the removal of the descriptive inorganic material.

Part II. 3. Justification/rationale for the revision.

The revision of this course is primarily a result of the program revisions proposed by the Department of Chemistry. These revisions were undertaken to modernize the chemistry curriculum, and to meet the new certification guidelines of the ACS. Descriptive inorganic material, which comprised the second half of the former 114 course, has been moved to CHEM 214. The result is that the topics that remain have been significantly expanded. Three topics formerly in CHEM 113 have been moved to CHEM 114, where they mesh well with other material in this course. For instance, the chapter on Gases and the chapter on Solids and Intermolecular Forces combines very naturally with Solutions to start the semester. The chemistry department faculty feel that by expanding the topics that will remain in CHEM 113 and 114, chemistry and biochemistry majors will be better prepared for subsequent courses in analytical and physical chemistry.

Part II. 4. Old syllabus of record.

COURSE SYLLABUS

I. Catalog Description

CH 114 Basic Inorganic Chemistry

4 credits
3 lecture hours
3 lab hours
(3c-3l-4sh)

Continuation of Concepts in Chemistry. Topics covered include chemical kinetics, equilibirum and thermodynamics, acids and bases, electrochemistry and descriptive chemistry of selected elements.

II. Course Objectives

A. Students will understand the basics of chemical kinetics and be able to derive rate laws.

B. Students will understand the basics of chemical equilibria and the factors that control it. Students will also be able to perform quantitative calculations related to the composition of equilibrium systems.

C. Students will understand the characteristics of acids and bases and the principles of weak acid equilibria.

D. Students will understand the fundamental qualitative and quantitative aspects of electrochemical cells and their associated oxidation-reduction reactions.

E. Students will understand the chemistry of coordination compounds.

F. Students will understand the descriptive chemistry of the main group elements. Descriptive chemistry of the elements involves a systematic presentations of the important compounds of each element along with their reactions and properties.

E. In the laboratory students will be able to apply the principles learned in lecture to qualitatively and quantitaively analyze experimental data they collect and explain its significance.

III. Course Outline (Lecture)

A. Chemical Kinetics: The Rates and Mechanisms of Chemical Reactions (3 lectures)
1. Reaction rates and rate laws
2. Effect of concentration and temperture on rates
3. Mechanisms

B. Chemical Equilibria: General Concepts (4 lectures)
1. Fundamental concepts of equilibria
2. The equilibrium constant
3. Equilibrium calculations

C. Acids and Bases (5 lectures)
1. Acid-base systems
2. pH scale
3. Weak Acids and Bases
4. Acid-Base Strength
5. Common-Ion Effect and Buffers

D. Oxidation-Reduction Reactions (4 lectures)
1. Electrochemical (oxidation-reduction) Reactions
2. Voltaic Cells and Standard Potentials
3. The Nerst Equation
4. Electrolytic cells and Faraday's Laws

E. Periodic Properties of the Elements (2 lectures)
1. Origin of the Periodic Table
2. Periodic Atomic Properties

F. Coordination Compounds (5 lectures)
1. Basic Characteristics of Coordination Compounds
2. Structures of Coordination Compounds
3. Bonding and Color in Coordination Compounds
4. Physical Properties of Transition Metals

G. The Chemistry of Hydrogen and the s-Block Elements (4 lectures)
1. The Chemistry of Hydrogen and Diagonal Relationships in the Periodic Table
2. The Alkali Metals: Group 1A
3. The Alkaline Earth Metals: Group 2A

H. Metals, Metalloids, Nonmetals: Periodic Groups 3A and 4A (4 lectures)
1. The Elements of Group 3A-Boron And Aluminum
2. The Elements of Group 4A-C Carbon, Silicon, Tin and Lead

I. The Chemistry of Nonmetals: Periodic Groups 5A Through 8A (7 lectures)
1. The Chemistry of the Elements Nitrogen, Phosphorus, Oxygen and Sulfur
2. The Chemistry of the Oxides and Halides
3. Chemistry of the Halogens
4. Noble Gas Compounds

IV. Evaluation Methods

60%	Exams - Four one-hour exams covering the material from the preceeding 3 weeks. These contain mulitple choice, short answer and essay questions as well as numerical problems. The fourth hour exam will be given at the time scheduled for the final exam.
10%	Quizzes - Periodic announced or unannounced quizzes covering the homework assignments and recent lecture material.
5%	Problem Sets - Questions or problems selected from the excersizes at the end of the chapter.
25%	Laboratory - Reports and quizzes from the laboratory portion of the course.

V. Required Texts
Lecture:
1. Kotz J.C.; Purcell, K.F. *Chemistry & Chemical Reactivity,* Saunders: Philadelphia, 1991.
or
2. Brown T.L.; Lemay, H.E., *Chemistry the Central Science,* Prentice-Hall: Englewood Cliffs, NJ, 1991.

Lab:
Abraham, M.R.; Pavelich, M.J.*Inquiries into Chemistry,* Waveland Press: Prospect Heights, IL, 1991.

VI. Special Resources Requirements

Each student is expected to purchase a pair of safety goggles for use in the laboratory.

VII. Bibliography

Mortimer, C. *Chemistry,* Wadsworth: New York, 1986.

Brown T.L.; Lemay, H.E., *Chemistry the Central Science,* Prentice-Hall: Englewood Cliffs, NJ, 1988.

Cotton, F. A.; Wilkinson, G. *Advanced Inorganic Chemistry,* John Wiley and Sons: New York, 1986.

Atkins, P.W. *Physical Chemistry,* Freeman and Co.: New York, 1986.

Skoog, D.A.; West, D.M. *Fundamentals of Analytical Chemistry,* Saunders: Philadelphia, 1988.

Summerlin, L.R.; Ealy, J.L. *Chemical Demonstrations: A Sourcebook for Teachers,* American Chemical Society: Washington D.C., 1985.

Summerlin, L.R.; Borgford C.L.; Ealy, J.L. *Chemical Demonstrations: A Sourcebook for Teachers, Vol. 2,* American Chemical Society: Washington D.C., 1987.

Articles from current issues of:
Journal of Chemical Education
Chemical and Engineering News
Chemtech
Isis
Today's Chemist

CH 114 LAB SCHEDULE

General Topic	Experiment
Kinetics	Bromination of Acetone (K-2)
Equilibria	Properties of a Precipitation Reaction (I-1)
Equilibria	Iron(III) Nitrate and Potassium Thiocyanate (I-4)
Equilibria	Acetic Acid (I-3)
Acid/Base Chemistry	Acid and Base Interactions (G-2)
Electrochemistry	Electrolysis (J-2)
Descriptive Chemistry	Chemical Properties (F-1)
Descriptive Chemistry	Chemsitry of Group 2 Elements (handout)
Descriptive Chemistry	Synthesis of Coordination Compounds (handout)
Descriptive Chemistry	Properties of Coordination Compounds (handout)
Descriptive Chemistry	Chemsitry of Group 14 Elements (handout)
Descriptive Chemistry	Halogens (F-2)

*The code in parethesis represents experiments taken from the required lab text: *Inquiries into Chemistry* by Abraham and Pavelich.

Part II. 5. LIBERAL STUDIES COURSE APPROVAL, PARTS I-III: GENERAL INFORMATION CHECK-LIST

I. Please indicate the LS category(ies) for which you are applying:

LEARNING SKILLS:

_____	First Composition Course	_____	Second Composition Course
_____	Mathematics		

KNOWLEDGE AREAS:

_____	Humanities: History	_____	Fine Arts
_____	Humanities: Philos/Rel Studies	_____	Social Sciences
_____	Humanities: Literature	_____	Non-Western Cultures
X	Natural Sci: Laboratory	_____	Health & Wellness
_____	Natural Sci: Non-laboratory	_____	Liberal Studies Elective

II. Please use check marks to indicate which LS goals are primary, secondary, incidental, or not applicable. When you meet with the LSC to discuss the course, you may be asked to explain how these will be achieved.

Prim	Sec	Incid	N/A	
				A. Intellectual Skills and Modes of Thinking:
X				1. Inquiry, abstract logical thinking, critical analysis, synthesis, decision making, and other aspects of the critical process.
	X			2. Literacy--writing, reading, speaking, listening.
X				3. Understanding numerical data.
		X		4. Historical consciousness.
X				5. Scientific Inquiry.
		X		6. Values (Ethical mode of thinking or application of ethical perception).
		X		7. Aesthetic mode of thinking.
X				**B. Acquiring a Body of Knowledge or Understanding Essential to an Educated Person**
	X			**C. Understanding the Physical Nature of Human Beings**
				D. Collateral Skills:
			X	1. Use of the library.
X				2. Use of computing technology.

III. The LS criteria indicate six ways that courses should contribute to students' abilities. Please check all that apply. When you meet with the LSC, you may be asked to explain your check marks.

_____	1. Confront the major ethical issues that pertain to the subject matter; realize that although "suspended judgment" is a necessity of intellectual inquiry, one cannot live forever in suspension; and make ethical choices and take responsibility for them.
X	2. Define and analyze problems, frame questions, evaluate available solutions and make choices.
X	3. Communicate knowledge and exchange ideas by various forms of expression, in most cases writing and speaking.
_____	4. Recognize creativity and engage in creative thinking.
_____	5. Continue learning even after the completion of their formal education.
X	6. Recognize relationships between what is being studied and current issues, thoughts, institutions, and/or events

V. A. This is not a multiple-section or multiple-instructor course.

B. The contributions of minorities and women to the development and advancement of chemistry will be included wherever possible including Maude Menten who worked with Leonor Michaelis to develop Michaelis-Menten Kinetics and Mary Hebraea, a first century alchemist who determined the formula for hydrochloric acid.

C. Articles from current issues of publications such as the *Journal of Chemical Education, Chemical and Engineering News, Today's Chemist at Work* will provide outside readings on current topics in Chemistry. *Chemical and Engineering News* is the weekly publication of the American Chemical Society that provides news of the chemical world including "worldwide coverage in the scientific, technological, educational, business, and governmental aspects of chemistry." *Today's Chemist at Work* is a monthly publication of the American Chemical Society that serves industrial chemists.

D. This is not an introductory course for a general student audience.

CHECK LIST -- NATURAL SCIENCES (Laboratory)

Knowledge Area Criteria which the course must meet:

_X_ Treat concepts, themes and events in sufficient depth to enable students to appreciate the complexity, history and current implications of what is being studied; and not be merely cursory coverage of lists of topics.

_X_ Suggest the major intellectual questions/problems which interest practitioners of a discipline and explore critically the important theories and principles presented by the discipline.

_X_ Allow students to understand and apply the methods of inquiry and vocabulary commonly used in the discipline.

_X_ Encourage students to use and enhance, wherever possible, the composition and mathematics skills built in the Skill Areas of Liberal Studies.

Natural Science Criteria which the course must meet:

_X_ Examine a body of knowledge of natural science that will contribute to an understanding of the natural world.

_X_ Provide an understanding of the development of natural science theories and their modification.

_X_ Teach students to formulate and test hypotheses.

_X_ Provide an understanding of some of the "great moments" in the history of natural science and the individuals, including women and minorities, responsible for them.

Natural Science Laboratory Criteria which the course must meet:

_X_ Provide students with opportunities to learn and apply data-gathering techniques.

_X_ Provide students with opportunities to develop skills in making accurate observations, in formulating concise and appropriate descriptions of natural phenomena, and in producing meaningful systems of classification for natural objects.

_X_ Provide students with opportunities to apply theories to practice in the working world of science.

Additional Natural Science Criteria which the course should meet:

_X_ Encourage an appreciation of the complex interrelationship of natural science with the life of the individual.

_X_ Develop in students the abilities necessary to cope with the consequences of natural science in the modern world.

_X_ Develop an inquiring attitude consistent with the tenets of natural sciences, an attitude that is willing to expose fallacy on the basis of reason, that demands evidence for scientific assertions, and yet is tolerant of hypotheses in the absence of contradictory evidence.