LSC Use Only Proposal No:	UWUCC Use Only Proposal No: 11-1259.
LSC Action-Date: AP-3/22/12	UWUCC Action-Date: App-4/3/12 Senate Action Date: App 4-17-12

Curriculum Proposal Cover Sheet - University-Wide Undergraduate Curriculum Committee

Contact Person(s) **Anne Kondo**	Email Address **akondo@iup.edu**
Proposing Department/Unit **Chemistry**	Phone 74595

Check all appropriate lines and complete all information. Use a separate cover sheet for each course proposal and/or 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

Current course prefix, number and full title: CHEM 114 Concepts in Chemistry II

Proposed course prefix, number and full title, if changing: CHEM 114 Advanced General Chemistry II

2. Liberal Studies Course Designations, as appropriate

__x__ This course is also proposed as a Liberal Studies Course (please mark the appropriate categories below)

_____ Learning Skills __X__ Knowledge Area _____ Global and Multicultural Awareness _____ Writing Intensive (include W cover sheet)

_____ Liberal Studies Elective (please mark the designation(s) that applies – must meet at least one)

_____ Global Citizenship _____ Information Literacy _____ Oral Communication

_____ Quantitative Reasoning _____ Scientific Literacy _____ Technological Literacy

3. Other Designations, as appropriate

_____ Honors College Course _____ Other: (e.g. Women's Studies, Pan African)

4. Program Proposals

_____ Catalog Description Change _____ Program Revision _____ Program Title Change _____ New Track

_____ New Degree Program _____ New Minor Program _____ Liberal Studies Requirement Changes _____ Other

Current program name:

Proposed program name, if changing:

5. Approvals	Signature	Date
Department Curriculum Committee Chair(s)		2/23/12
Department Chairperson(s)		2/23/12
College Curriculum Committee Chair	Anne Kondo	3/9/12
College Dean		3/12/12
Director of Liberal Studies (as needed)		3/26/12
Director of Honors College (as needed)		
Provost (as needed)		
Additional signature (with title) as appropriate		
UWUCC Co-Chairs	Gail Sechrist	4/3/12

Received
MAR 26 2012
Liberal Studies

Received
MAR 12 2012
Liberal Studies

Part II.

New Syllabus of Record

1. Catalog Description

CHEM 114 Advanced General Chemistry II (3c-3l-4cr)

Prerequisites: C or better in CHEM 113

A continuation of Advanced General Chemistry I. Topics include solutions, chemical kinetics, equilibrium and thermodynamics, acids and bases, buffers, and electrochemistry. Topics will be covered in greater depth and with more challenging problem solving than General Chemistry. Designed for majors within the College of Natural Sciences and Mathematics and to fulfill the Liberal Studies Natural Science Laboratory Sequence requirement for those students.

2. Course Outcomes

Objective 1: Students will understand the molecular basis of solution formation, of chemical kinetics and its connection to reaction mechanisms, of chemical equilibria, and of acid and base chemistry. They will be able to derive and analyze rate laws, predict the products of acid-base reactions, and explain how a battery is constructed.

Expected Student Learning Outcomes 1&2: Informed and empowered learners.

Rationale: Exams, homework assignments and laboratory reports will determine whether students understand on a molecular level how chemical reactions occur, and what they can do to influence them.

Objective 2: B. Students will be able to calculate reaction concentrations at any time during a reaction, calculate how long a reaction should take, calculate equilibrium concentrations, predict the effect of stresses on a chemical equilibrium, and calculate concentrations, electrical outputs and thermodynamic properties of batteries.

Expected Student Learning Outcomes 1&2: Informed and empowered learners.

Rationale: In lecture, students will develop and apply problem-solving skills to solve advanced kinetics, equilibrium and electrochemical problems, involving all states of matter and related energy changes. In lab, student apply quantitative analysis to experimental measurements.

Objective 3: In the laboratory, students will apply the principles learned in lecture to qualitatively and quantitatively collect and analyze experimental data related to kinetics, equilibrium and electrochemistry. Students will learn experimental design, proper communication of scientific results, safety laboratory behavior and proper chemical disposal.

Expected Student Learning Outcomes 2&3: Empowered and responsible learners.

Rationale: Students will apply the language of chemistry in weekly experiments. They will apply quantitative reasoning in data collection and analysis. Students will be able to design experiments to test their ideas, and to draw relevant conclusions. Students will practice safe laboratory behavior, including

the safe handling of instruments and hazardous materials, to prevent injury to themselves or others, or harm to the environment.

3. Detailed Course Outline

Advanced General Chemistry II is intended to be a single lecture section with multiple lab sections. Ideally , one instructor will cover lecture and lab, although in some semesters, additional instructors may be needed to cover one or two lab sections.

Lecture Topics

1 hr = one 50 minute lecture

1. Properties of Solutions — 5 hours

   Solutes, solvents, how dissolution occurs, colligative properties

2. Chemical Kinetics: The Rates and Mechanisms of Chemical Reactions — 6 hours

   Reaction rates and rate laws. Effect of concentration and temperature on rates. Mechanisms.

3. Chemical Equilibria — 6 hours

   Fundamental concepts of equilibria. Equilibrium constants. Equilibrium calculations.

4. Acids and Bases — 5 hours

   Products of acid-base reactions. pH. Strong vs. weak acids and bases.

5. Acid-Base Equilibria — 6 hours

   K_a. Salt solutions. Titrations. Buffers.

6. Spontaneous Change — 5 hours

   Entropy and Disorder. Reaction Entropy. Free Energy

7. Electrochemistry — 5 hours

   Oxidation-reduction reactions. Voltaic cells and standard potentials. Electrolytic cells and Faraday's law. The Nernst Equation

   Four one-hour exams dispersed through the semester — 4 hours

   The final exam will occur during the final exam period.

Laboratory Topics - one laboratory period for each experiment

1. Check-in, Safety
2. Studies of a Precipitation Reaction
3. Analysis of Water
4. Kinetics Factors
5. Bromination of Acetone
6. Decomposition of Hydrogen Peroxide

7. Shifting Reactions
8. Iron (III) Nitrate and Potassium Thiocyanate
9. Acid and Base Classifications
10. Acetic Acid
11. Analysis of a Buffer
12. Oxidation-Reduction Reactions And Voltaic Cells
13. Electrolysis Reactions
14. Check-out, Final Lab Exam

4. Evaluation Methods

Exams	= 60%
In-class and Homework Assignments	= 15%
Laboratory Grade	= 25%
TOTAL POINTS:	= 100%

The laboratory grade will make up 25% of the overall grade. Lecture evaluation consists of quizzes, hourly exams, assignments and a final exam. The final exam usually contributes 25-30% of the lecture grade. The laboratory grade is made up of quiz grades (20% of lab grade for regular quizzes, and 10 % of lab grade for final lab exam) and grades on laboratory reports and/or notebooks (70% of lab grade). The student must earn 70% in the laboratory in order to pass CHEM 114.

5. Example Grading Scale

Final course grade is determined by the percentage earned by the student in both lecture and laboratory.

$A \geq 90\%$ $B \geq 80\%$ $C \geq 70\%$ $D \geq 60\%$ $F < 60\%$

6. Undergraduate Course Attendance Policy

The University expects all students to attend class. The attendance policy for this course will be consistent with the Undergraduate Course Attendance Policy in the IUP Undergraduate Catalog.

7. Required textbook(s)
Lecture: Atkins, P., Jones L., *Chemical Principles, 5th ed.*, W.H. Freeman, NY, 2010.

Laboratory: Abraham,M. R.; Pavelich, M. J., *Inquiries into Chemistry,* Waveland Press, Inc., Prospect Heights, Il.,1999. (This laboratory manual has an older publication date, but remains one of the best guided inquiry chemistry laboratory manuals available.)

8. Special Resource Requirements

Safety: Some approved form of eye protection must be worn at all times in the laboratory. Students who do not comply with this regulation will be required to withdraw from the course.

Students are expected to have their own scientific calculators and access to a computer to use the computer-based programs and web-sites that provide supplementary materials. Some sections of the course may utilize on-line course materials as part of the instruction.

9. Bibliography

Brown, T.E., LeMay, H.E., Bursten, B.E., Murphy, C., Woodward, P., *Chemistry: The Central Science*, 12th ed., Prentice Hall, New Jersey, 2012

Garratt, J., Threlfall, R., Overton, T, *A Question of Chemistry: Creative Problems for Critical Thinkers,* Prentice Hall , NJ, 2000.

Jespersen, N.D., Brady, J.E., Hyslop, A., *Chemistry: The Molecular Nature of Matter*, 6th Ed., J. Wiley and Sons, N.J., 2011.

McGrayne, S. Bertsch, *Nobel Prize Women in Science: Their Lives, Struggles and Momentous Discoveries*, **2nd Ed.** Joseph Henry Press: Washington, DC, 2001

Morse, Mary, *Women Changing Science: Voices from a Field in Transition,* Perseus Publishing, Cambridge, MA, 2001.

Oxtoby, D.W., Gillis, H. P., Campion, A., *Principles of Modern Chemistry*, 7th Ed., Brooks-Cole, Connecticut, 2012.

Petrucci, R.H., Herring, F.G., Madura, J.D., Bissonnette, C., *General Chemistry: Principles and Modern Applications*, 10th ed., Prentice Hall , NJ, 2011.

Shearer, B.F., Shearer, B.S., Eds., *Notable Women in the Physical Sciences: A Biographical Dictionary*, Greenwood Press (1997).

Spencer, J.N., Bodner, G.M., Rickard, L.H., *Chemistry: Structure and Dynamics*, 5th Ed., J. Wiley and Sons, NJ, 2010.

Thompson, G.L., *Unheralded but Unbowed: Black Scientists and Engineers that Changed the World,* CreateSpace, 2009.

SAMPLE ASSIGNMENT

CHEM 114 **Acid-Base Review**

Your ability to correctly calculate the concentrations and pH of the systems below relies heavily on your ability to identify the reactants and products as strong acids, strong gases, weak acids, weak bases, acidic salts, basic salts or neutral salts. The stoichiometry can be solved using the techniques learned last semester (and practiced this semester).

1. Use ICE tables to write the reactions and/or equilibria that are finally present with the following mixtures.
   (a) 50.00 mL 1.00 M HCl and 25.00 mL 1.00 M NaOH

   (b) 50.00 mL 1.00 M HCl and 50.00 mL 1.00 M NH_3

   (c) 25.00 mL 1.00 M HCl and 50.00 mL 1.00 M NH_3

   (d) 10.00 mL 1.00 M HCl, 50.00 mL 1.00 M NH_3 and 40.00 mL 1.00 M NH_4Cl

2. 24.00 mL of 0.200 M HF is titrated with 0.300 M KOH. Calculate the pH at the following points in the titration, given $K_a(HF) = 7.1 \times 10^{-4}$. Show your ICE tables and steps of your calculation.
   (a) 0.00 mL KOH, (b) 8.00 mL KOH (c) the equivalence point

3. What is the pH of 50.00 mL of a buffer that is 0.400 M NH_3 and 0.420 M NH_4Br? $K_b(NH_3) = 1.8 \times 10^{-5}$. Show your ICE table and steps of your calculation. Classify reactants and products as SA, SB, WA, WB, or salt, as appropriate.

4. What is the pH of the buffer in question # 3 after 5.00 mL of 0.500 M NaOH is added? Explain why the pH changed in the direction it did. Show your ICE table and steps of your calculation. Classify reactants and products as SA, SB, WA, WB, or salt, as appropriate.

Sample Assessment

CHEM 114: Grading Rubric for Acid-Base Review

Question 1: Each problem gives the correct chemical reaction(s), ICE Table and correctly predicts the species remaining after chemical reaction. (5 points each; 20 points total)

Question 2: Each calculation gives a word equation, number substitution, and shows appropriate unit analysis. ICE table is correct. Dilution calculations are correct. Final pH is correct (10 points each, 30 points total)

Question 3: Each calculation gives a word equation, number substitution, and shows appropriate unit analysis. ICE table is correct. Species are correctly classified. Final pH is correct. (20 points total).

Question 4: Each calculation gives a word equation, number substitution, and shows appropriate unit analysis. ICE table is correct. Species are correctly classified. Final pH is correct. Explanation is correct. (30 points total).

Total points: 100

End of sample assignment/assessment

2. Summary of the proposed revisions.

1. Course title change from "Concepts in Chemistry II" to "Advanced General Chemistry II"
2. Pre-requisite of "C" or better in CHEM 113 is added
3. Catalog Description change
4. Change in course objectives to fit expected student learning outcomes.
5. Minimum Lab Grade of 70% required for passing course.
6. Updated course text and bibliography
7. Included sample lecture assignment and grading rubric associated with Objectives2&3.

3. Justification/rationale for the revision.

1. **Course title and pre-requisite changes** align with changes to CHEM 113. CHEM 114 is a continuation of CHEM 113. Like CHEM 113, CHEM 114 is targeted to better-prepared students. The content and problem-solving of the course will be more challenging than CHEM 112, General Chemistry II; the laboratory program will continue to be based on guided inquiry. The revision to Advanced General Chemistry is designed to challenge and to improve retention of science majors. In keeping with that change, a pre-requisite of "C" is added to CHEM 114. Students who earn a "D" in CHEM 113 would be advised to retake CHEM 113, or transfer over to CHEM 112. CHEM 112 (General Chemistry II) is an existing liberal studies Natural Science course for science majors. Because the core content of the CHEM 112 and CHEM 114 will be the same, students should be able to count CHEM 112 as their Liberal Studies Science. The chemistry department hopes these changes improve retention of all science majors, and chemistry majors in particular.
2. **Catalog Description changes** reflect the distinction between General Chemistry II and Advanced General Chemistry II, and to keep the elevated academic standard of the course. Students with a "D" in CHEM 113 will be directed into CHEM 112, the regular General Chemistry II.
3. **Change in course objectives** to fit expected student learning outcomes.
4. Minimum Lab Grade of 70% required for passing course was the recommendation of two external evaluators at our last program review. Faculty approved raising the minimum passing lab grade from 65% to 70% to improve student learning and standards.
5. Updated course text and bibliography - the syllabus of record was last updated in 2003.
6. Included sample lecture assignment and grading rubric associated with Objectives2&3.
7. Requested exemption from reading non-textbook fact or fiction book due to the high degree of quantitative analysis in the course.

4. The old syllabus of record for CHHEM 114.

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:

Laboratory Schedule

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

Answers to Liberal Studies Questions CHEM 114: Advanced General Chemistry II

Liberal Studies Course Approval General Information

1. This course will have one lecture section. The lecture instructor will serve as course (lecture and lab) coordinator. All lab sections will do the same set of experiments. There is a department guideline standard evaluation procedure for all sections that requires a student to earn 70% in the laboratory portion of the course in order to pass.

2. Many important discoveries and advances in chemistry come from women and ethnic minorities: Madam Curie's discovery of radiation, Marie-Anne Lavoisier's translations and equipment sketches in the 1800s, George Washington Carver's contributions to plant chemistry, the periodic table described by Mendeleev. These landmark scientists and others are mentioned texts and by instructors.

3. The exception to non-textbook work is made due to the quantitative nature of the course in both lecture and laboratory. Student derive and use kinetic rate laws, perform dilution, titration, pH calculations and thermodynamic analysis. Students are required to use calculators for complex algebraic problem-solving and for logarithmic functions like pH. In lab, students will use computers for data collection, and will be expected to use software to graph and analyze their results.

4. General Chemistry II (CHEM 112) is the second introductory chemistry course for science majors. This course starts from first principles of quantitative and qualitative analysis of matter, and develops those ideas throughout the course. We believe that CHEM 112 does not serve, as well as it should, those students who have had chemistry in high school and who have good math skills. CHEM 114 is a freshman general chemistry course intended for those better prepared students, and as such is not a true first course in a major sequence. On the other hand, because CHEM 114 covers the same general content as CHEM 112 (although more complex concepts are covered to a greater depth because less time is spent on introductory skills), we request that CHEM 114 be the Liberal Studies Natural Science course for those better-prepared students. CHEM 114 will no longer be restricted to chemistry (and chemistry-related) majors. We intend to challenge all well-prepared science majors with this first university course in chemistry. We hope this change will help us better retain both science majors and chemistry majors, by placing less-prepared science majors in CHEM 112, and invigorating the better-prepared science majors in CHEM 114.

Liberal Studies Course Approval Checklist
Instruction Sheet

Use this checklist for all Liberal Studies categories other than writing-intensive sections; a different checklist is available for this. If you have questions, contact the Liberal Studies Office, 103 Stabley, telephone 357-5715.

This checklist is intended to assist you in developing your course to meet IUP's Criteria for Liberal Studies and to arrange your proposal in a standard order for consideration by the Liberal Studies Committee (LSC) and the University-Wide Undergraduate Curriculum Committee (UWUCC). When you have finished, your proposal will have these parts:

____ Standard UWUCC Course Proposal Cover Sheet, with signatures and Liberal Studies course designation checked

____ Course syllabus in UWUCC format

____ UWUCC course analysis questionnaire. Needed only if this is a new course not previously approved by the University Senate. These are not considered by the LSC but will be forwarded to the UWUCC along with the rest of the proposal after the LSC completes its review.

____ Assignment instructions for one of the major course assignments and a grading rubric or grading criteria for that assignment

____ Answers to the four questions listed in the Liberal Studies Course Approval General Information (one page)

Submit the original of the completed proposal to the Liberal Studies Office (103 Stabley). In addition to the signed hard copy, email the proposal as a Word or RTF file attachment to Liberal-Studies@iup.edu.

Please Number All Pages