Agenda Item #15-125
Effective Spring 2016

Eastern Illinois University
Revised Course Proposal
CHM 1410, General Chemistry II

Banner/Catalog Information (Coversheet)

1. **___New Course or _X___Revision of Existing Course**

2. **Course prefix and number:** ____CHM 1410

3. **Short title:** _____General Chemistry II

4. **Long title:** ___General Chemistry II

5. **Hours per week:** _3__ Class _0_ Lab _3_ Credit

6. **Terms:** _X_ Fall _X__ Spring ___ Summer ___ On demand

7. **Initial term**: ___ Fall _X__ Spring ___Summer Year: _2016__

8. **Catalog course description:** ___ The second semester of the general chemistry sequence. Principles and applications of intermolecular forces, solutions, equilibrium, kinetics, thermodynamics, acid-base concepts, and electrochemistry. BIO 907; CHM 912; NUR 907.

9. **Course attributes:**

   General education component: ____Not applicable

   ___ Cultural diversity ___Honors ____Writing centered ___ Writing intensive _X_Writing active

10. **Instructional delivery**
    Type of Course:

    _X__ Lecture ___ Lab ___ Lecture/lab combined ___ Independent study/research

    ___ Internship ___ Performance ___ Practicum/clinical ___Other, specify: _____

    Mode(s) of Delivery:

    _X__ Face to Face ___Online ___Study Abroad

    ___ Hybrid, specify approximate amount of on-line and face-to-face instruction_____

    Course(s) to be deleted from the catalog once this course is approved. ___NONE_____

11. **Equivalent course(s):** ____NONE

    a. Are students allowed to take equivalent course(s) for credit? ___ Yes ___ No

12. **Prerequisite(s):** ___A grade of C or better in both CHM 1310G and 1315G

    a. Can prerequisite be taken concurrently? ___ Yes __X_ No

    b. Minimum grade required for the prerequisite course(s)? _C__

    c. Use Banner coding to enforce prerequisite course(s)? _Y_ Yes ___ No

d. Who may waive prerequisite(s)?

___ No one __X__ Chair ___ Instructor ___ Advisor ___Other (specify)

13. Co-requisite(s): __CHM 1415 must be taken concurrently_____

14. Enrollment restrictions

a. Degrees, colleges, majors, levels, classes which may take the course: ____All_____

b. Degrees, colleges, majors, levels, classes which may not take the course: ___None_____

15. Repeat status: _X__ May not be repeated ___ May be repeated once with credit

16. Enter the limit, if any, on hours which may be applied to a major or minor: _3___

17. Grading methods: _X_ Standard ___ CR/NC __ Audit ___ ABC/NC

18. Special grading provisions:

_n/a_ Grade for course will not count in a student's grade point average.

_n/a _Grade for course will not count in hours toward graduation.

_n/a _ Grade for course will be removed from GPA if student already has credit for or is registered in: _____

_n/a__ Credit hours for course will be removed from student's hours toward graduation if student already has credit for or is registered in: _____

19. Additional costs to students:
Supplemental Materials or Software ____n/a_____

Course Fee _X__No ___Yes, Explain if yes_____

20. Community college transfer:

_X__ A community college course may be judged equivalent.

___ A community college may not be judged equivalent.

Note: Upper division credit (3000+) will not be granted for a community college course, even if the content is judged to be equivalent.

Rationale, Justifications, and Assurances (Part I)

1. _X_ Course is required for the major(s) of __BS in Chemistry (all concentrations); BA in Chemistry; BS in Biological Sciences; Family and Consumer Science (Dietetics Option BS); BS in Clinical Lab Sciences; BS in Geology; BS in Physics (including Applied Physics Option, Pre-Engineering Physics, Radiation Physics Option); BS Engineering; BS in Science Teacher Licensure (Biological Sciences Specialization, Chemistry Specialization, Physics Specialization, Earth Sciences Specialization) plus any "Pre-Health" Curriculum.
2. _X_Course is required for the minor(s) of ____Chemistry_____
   ___Course is required for the certificate program(s) of _____
   ___ Course is used as an elective
3. **Rationale for proposal**: This revised course proposal is being submitted to comply with the new course proposal guidelines as set forth by CAA in 2014. The previous CHM 1410 course proposal could not be located; therefore this new course proposal will be suitable for publication in the EIU electronic course library and for submission to the Illinois Articulation Initiative (IAI).
4. **Justifications for (answer N/A if not applicable)**

   Similarity to other courses: N/A

   Prerequisites: As noted in the IAI guidelines, General Chemistry is almost universally regarded as a sequential two-semester, lecture and lab experience. Success in General Chemistry II therefore naturally relies on successful completion of General Chemistry I (both lecture and lab). Therefore, the prerequisites of a grade of C in both CHM 1310G (General Chemistry I – lecture) and CHM 1315G (General Chemistry Laboratory I) are necessary to maximize the probability of success in General Chemistry II.

   Co-requisites: Comprehension of the principles presented in lecture (CHM 1410) is enhanced if these principles are demonstrated in the lab (CHM 1415). Therefore, CHM 1415 is a co-requisite.

   Enrollment restrictions: N/A

   Writing active, intensive, centered: The "writing active" designation is justified since many exams and quizzes require both short-answer and problem-solving skills.

5. **General education assurances (answer N/A if not applicable)**

   General education component: N/A

   Curriculum: N/A

Instruction: N/A

Assessment: N/A

6. **Online/Hybrid delivery justification & assurances (answer N/A if not applicable)**

Online or hybrid delivery justification: N/A

Instruction: N/A

Integrity: N/A

Interaction: N/A

Model Syllabus (Part II)

Please include the following information:

1. **Course number and title**: CHM 1410 (General Chemistry II)

2. **Catalog description:** The second semester of the general chemistry sequence. Principles and applications of intermolecular forces, solutions, equilibrium, kinetics, thermodynamics, acid-base concepts, and electrochemistry. BIO 907; CHM 912; NUR 907.

3. **Learning objectives:**

Course-Specific Learning Objectives *At the end of this course, students will be able to…*	**Corresponding Undergraduate University Learning Goals**
Understand how molecules interact in solution and the gas phase and apply this understanding to predict how a chemical system might behave under various conditions.	WR-5. Understanding, questioning, analyzing, and synthesizing complex textual, numeric, and graphical sources.
Apply mathematical models to quantitatively describe the properties of solutions.	QR-1. Performing basic calculations and measurements. QR-2. Applying quantitative methods and using the resulting evidence to solve problems.
Understand the concepts of reaction rate, chemical equilibrium, and acid-base reactions and apply this understanding to predict the direction, rate, and outcome of chemical reactions.	QR-1. Performing basic calculations and measurements. QR-2. Applying quantitative methods and using the resulting evidence to solve problems. QR-3. Reading, interpreting, and constructing tables, graphs, charts, and other representations of quantitative material. QR-5. Constructing cogent arguments utilizing quantitative material. WR-5. Understanding, questioning, analyzing, and synthesizing complex textual, numeric, and graphical sources.

Understand the concepts of enthalpy, entropy, free-energy changes in chemical reactions, and the relationship between chemical equilibrium and chemical kinetics, and apply this understanding to predict the direction and energy changes involved in chemical reactions.	QR-1. Performing basic calculations and measurements. QR-2. Applying quantitative methods and using the resulting evidence to solve problems. QR-3. Reading, interpreting, and constructing tables, graphs, charts, and other representations of quantitative material. QR-5. Constructing cogent arguments utilizing quantitative material. WR-5. Understanding, questioning, analyzing, and synthesizing complex textual, numeric, and graphical sources.
Understand the basic concepts of electron transfer reactions, voltaic cells, and electrolysis, and apply mathematical methods to predict the energy storage capabilities of these devices.	QR-1. Performing basic calculations and measurements. QR-2. Applying quantitative methods and using the resulting evidence to solve problems. QR-5. Constructing cogent arguments utilizing quantitative material. WR-5. Understanding, questioning, analyzing, and synthesizing complex textual, numeric, and graphical sources.

4. Course materials:

Text: Brown, T.L.; LeMay, H.E.; Bursten, B.E.; Murphy, C.J.; Woodward, P.M.; Stoltzfus, M.W. *Chemistry: The Central Science*, 13th ed., Pearson: New York, 2015.

Supplement: Brown, T.L. et al. *Solutions to Red Exercises for Chemistry: The Central Science, 13th ed.*, Pearson, New York, 2015.

On-Line HW System: *Mastering Chemistry*, Pearson, New York. Free access for students enrolled in the course.

5. Weekly outline of content:

Week #	Description of Content
1	Liquids and Intermolecular Forces • Dispersion, dipole-dipole, ion dipole, H-bonding (and comparison of magnitudes of these forces) • Viscosity, surface tension, and capillary action of liquids • Heating curves and phase diagrams, critical temperature and pressure • The concept of vapor pressure and its relationship to temperature and intermolecular forces; Clausius-Clapeyron equation
2	Properties of Solutions • Energetics of solution formation • The concept of solubility and saturated vs. unsaturated solutions • Factors affecting solubility: solute-solvent interactions, pressure and temperature effects; Henry's Law • Quantitative description of solutions concentration: mass %, ppm, ppb, mole fraction, molarity, molality; conversions between concentration units

3	Properties of Solutions (cont'd) • Colligative Properties – vapor pressure lowering, Raoult's Law, boiling point elevation, freezing point depression • Molal freezing point depression and molal boiling point elevation constants; calculating freezing point depression and boiling point elevation • Osmosis, osmotic pressure calculations • Van't Hoff factor, ion-pairing • Calculating molar mass from osmotic pressure data • Colloids
4	Chemical Kinetics • Qualitative factors affecting reaction rates • Definition of reaction rate, instantaneous vs. average rate, relationship between rate expressions and stoichiometry • Concentration effects on rates; rate laws, reaction order, rate constant, deriving a rate law from concentration vs rate data, first, second, and zero-order reactions (including graphical representations)
5	Chemical Kinetics (cont'd) • The collisional model of chemical kinetics, including orientation factors; the effect of temperature on reaction rates • Arrhenius equation; determination and meaning of activation energies. • Reaction mechanisms, rate laws for elementary reactions, multi-step reactions, rate-determining steps, derivation of a rate law from a proposed mechanism • Heterogeneous and homogeneous catalysis, enzyme catalysis
6	Chemical Equilibrium • Qualitative description of the concept of reaction equilibrium • Equilibrium constant expressions in terms of partial pressures and concentration units, equilibrium constants, dealing with heterogeneous equilibria • Evaluating the meaning of large and small equilibrium constants. • Calculating equilibrium constants
7	Chemical Equilibrium(cont'd) • Predicting the initial direction of approach to equilibrium; reaction quotient • Calculating final concentrations of reactants and products using initial concentrations and an equilibrium constant • LeChatelier's Principle – effect of concentration, volume, pressure and temperature changes and catalysts
8	Acid-Base Equilibria • Definitions used for acid-base chemistry – Arrhenius, Bronsted-Lowry, Lewis; conjugate acid-base pairs • Qualitative discussion of the meaning of acid and base strength • Autoionization of water, ion-product of water (K_w), pH scale, measurement of pH

9	<u>Acid-Base Equilibria(cont'd)</u> • Quantitative discussion of the strengths of acids and bases: acid and base ionization constants (K_a and K_b) • Strong acids and bases vs. weak acids and bases, percent ionization • Calculation of K_a and K_b from pH and vice versa • Acid-Base properties of salt solutions, calculation of pH of salt solutions. • Relationship between acid and base strength and molecular structure
10	<u>Additional Aspects of Equilibria</u> • The common-ion effect • Composition and action of buffers; Henderson-Hasselbalch equation, buffer capacity and range of optimum efficiency, calculating pH changes upon addition of strong acids or bases to buffers • Acid-Base Titrations – strong acid/strong base, weak acid by strong base, weak base by strong acid • Construction and evaluation of titration curves – calculating pH before, at, and after the equivalence point • Equivalence point vs. endpoint
11	<u>Additional Aspects of Equilibria(cont'd)</u> • Acid-base indicators and how to choose the optimum indicator • Solubility equilibria, solubility product constant (K_{sp}), factors that affect solubility including temperature and pH • Complex ion formation, complex ion formation constant (K_f) • Precipitation and separation of ions, predicting whether or not a precipitate will form from solubility and concentration data • Introduction to qualitative analysis involving metal ions
12	<u>Chemical Thermodynamics</u> • Review the First Law of Thermodynamics • The concept of a spontaneous reaction, reversible and irreversible processes • Introduction to entropy and entropy changes (ΔS) and the Second Law of Thermodynamics • The Third Law of Thermodynamics and the molecular interpretation of entropy; making qualitative predictions about ΔS
13	<u>Chemical Thermodynamics (cont'd)</u> • Surroundings vs. system vs. universe; entropy changes in chemical reactions • Introduction to Gibbs Free Energy (G) and changes in free energy (ΔG); relationship between ΔG and the equilibrium constant K • Free energy as a function of temperature • Calculating ΔG^o from standard free energies of formation; calculating free energy changes under nonstandard conditions
14	<u>Electrochemistry</u> • Identifying oxidation-reduction (redox) reactions; review of assignment of oxidation numbers • Identifying oxidizing and reducing agents • Balancing redox reactions in both acidic and basic solutions • Introduction to voltaic cells; half reactions • Calculation of cell potentials under standard conditions; standard reduction potentials

15	Electrochemistry (cont'd) • Calculation of cell potentials under nonstandard conditions • Relative strengths of oxidizing and reducing agents • Relationship between free energy changes and cell potentials and equilibrium constants • Concentration cells, measurement of pH • Batteries and fuel cells • Corrosion processes • Electrolysis and electrolytic cells, electroplating, metallurgy
16	Final Exam

6. Assignments and evaluation, including weights for final course grade:

Assignments/Quizzes (20-40%): Instructors typically use an online HW system, paper-based HW assignments, or in-class quizzes, or a combination of two or all of these. An example of an online HW system is the Pearson Higher Education *Mastering Chemistry* which can use end-of-chapter problems from the textbook, includes tutorials for multiple-choice questions involving reasoning, concept recognition, and calculations, and allows for instructor-derived questions.

Exams (in-class) (40-60%): These exams will typically have a mix of multiple-choice and problem solving/short-answer questions evaluating both conceptual understanding and quantitative/reasoning skills.

Final Exam (15-25%): Similar in format to the hour exams.

7. Grading scale: Standard A, B, C, D, F grading scale.

8. Correlation of learning objectives to assignments and evaluation:

Learning Objective	**Assignments/Quizzes (20-40%)**	**Exams – in class (40-60%)**	**Final Exam (15-25%)**
Understand how molecules interact in solution and the gas phase and apply this understanding to predict how a chemical system might behave under various conditions.	X	X	X
Apply mathematical models to quantitatively describe the properties of solutions.	X	X	X

Understand the concepts of reaction rate, chemical equilibrium, and acid-base reactions and apply this understanding to predict the direction, rate, and outcome of chemical reactions.	X	X	X
Understand the concepts of enthalpy, entropy, free-energy changes in chemical reactions, and the relationship between chemical equilibrium and chemical kinetics, and apply this understanding to predict the direction and energy changes involved in chemical reactions.	X	X	X
Understand the basic concepts of electron transfer reactions, voltaic cells, and electrolysis, and apply mathematical methods to predict the energy storage capabilities of these devices.	X	X	X

Date approved by the department or school: August 28, 2015

Date approved by the college curriculum committee: September 4, 2015

Date approved by the Honors Council *(if this is an honors course):*

Date approved by CAA: September 17, 2015 CGS: Not Applicable