ILLINOIS VALLEY COMMUNITY COLLEGE

COURSE OUTLINE

DIVISION: Natural Sciences Business

COURSE: 1007

Date: Revised 9/26/13 for Fall 2013

Credit Hours: 5

Prerequisite(s): Chm 1006

Delivery Method:		
	☒ **Lecture**	**3 Contact Hours (1 contact = 1 credit hour)**
	☒ **Seminar**	**1 Contact Hours (1 contact = 1 credit hour)**
	☒ **Lab**	**2 Contact Hours (2 contact = 1 credit hour)**
	☐ **Clinical**	**0 Contact Hours (3 contact = 1 credit hour)**
	☐ **Online**	
	☐ **Blended**	

Offered: ☐ **Fall** ☒ **Spring** ☒ **Summer**

IAI Equivalent –***Only for Transfer Courses***-go to *http://www.itransfer.org*: P1902

CATALOG DESCRIPTION:

This course is a continuation of CHM 1006. Topics include kinetics, equilibrium, acid-base theories, buffers, electrochemistry, coordination chemistry, nuclear chemistry and organic chemistry. Laboratory includes gravimetric, volumetric, electroanalytic, and spectrophotometric methods of analysis.

GENERAL EDUCATION GOALS ADDRESSED

Upon completion of the course, the student will be able:

☒ To apply analytical and problem solving skills to personal, social and professional issues and situations.
☐ To communicate orally and in writing, socially and interpersonally.
☐ To develop an awareness of the contributions made to civilization by the diverse cultures of the world.
☒ To understand and use contemporary technology effectively and to understand its impact on the individual and society.
☒ To work and study effectively both individually and in collaboration with others.
☒ To understand what it means to act ethically and responsibly as an individual in one's career and as a member of society.
☐ To develop and maintain a healthy lifestyle physically, mentally, and spiritually.
☐ To appreciate the ongoing values of learning, self-improvement, and career planning.

EXPECTED LEARNING OUTCOMES AND RELATED COMPETENCIES:
Upon completion of the course, the student will be able to:

Outcome 1 - *Students will be able to demonstrate an understanding of chemical kinetics*

1. Define reaction rate both in words and in a mathematical statement.

2. Draw an energy vs. reaction coordinate diagram and indicate energy of reactants, activation energy, energy of products, effect of catalyst, whether the reaction is exothermic or endothermic, and discuss those concepts in writing.

3. Draw labeled Maxwell-Boltzman curves for two different temperatures and discuss why high temperature leads to higher reaction rates.

4. Define and give examples of homogeneous and heterogeneous catalysis.

5. Determine the order of a reaction given the equation and the effect of concentration change on the initial rate of reaction.

6. Define and illustrate rate determining step, reaction mechanism, and chain mechanism.

7. Solve problems using the integrated rate law equations including half-life calculations.

Outcome 2- *Students will be able to demonstrate an understanding of basic chemical equilibrium*

1. Define equilibrium and give examples of systems at equilibrium, both physical and chemical.

2. Given a chemical reaction, set up the equilibrium expression.

3. State LeChatelier's Principle and apply it to predict the effect of changes in temperature, concentration, pressure, on a system at equilibrium.

4. Predict the effect of changes in temperature, concentration, pressure, and catalyst on the equilibrium constant.

5. Relate the completeness of reaction to a specific equilibrium constant.

6. Solve equilibrium problems such as:
   a. Calculation of the constant from initial concentration and one equilibrium concentration.
   b. Calculation of equilibrium concentrations from initial concentrations and the equilibrium constant.
   c. Calculate the equilibrium constant given the equilibrium concentrations.

Outcome 3- *Students will be able to demonstrate an understanding of solubility equilibrium and K_{sp} calculations.*

1. Write the K_{sp} expression given the formula of the salt and determine its value given the solubility of the salt in g/l or moles/l and vice versa.

2. Predict whether or not a precipitate will form given the K_{sp} and concentrations of solutions to be mixed.

3. Describe four methods that can be used to dissolve insoluble salts from the standpoint of equilibrium theory.

4. Describe the basis of the group separations in qualitative analysis using equilibrium theory, K_{sp} values and K_a or K_b.

5. Determine by calculations which salt will precipitate first given the conc of the salts and K_b values.

6. Solve problems involving multiple equilibria.

Outcome 4- *Students will be able to demonstrate an understanding Acid-Base Equilibrium and related calculations.*

1. Define: Lewis acid and base, Arrhenius acid and base, Bronsted-Lowrey acid and base, amphiprotic, leveling effect, conjugate acid and base.

2. Complete equations for the preparation of acids and bases.

3. Given a reaction and using the Bronsted Theory identify the acid, base, conjugates.

4. Given a list of acids and K_a values, place them in order of acid strength.

5. Describe the properties of an acid or base in view of the Arrhenius theory.

6. Given an equation explain the reaction in light of the Lewis acid-base theory, or given reactants predict the products in light of this theory.

7. Identify weak and strong electrolytes; know the six common strong acids and the common strong bases.

8. Write the K^i expression for a weak acid or weak base.

9. Calculate the H^+ conc. of a solution of a weak acid or base given the initial conc. and the K_a or K_b.

10. Describe the salt effect on ionization.

11. Apply the common ion effect and LeChatelier's Principle to situations involving weak acids and bases.

12. Know the ion product value (K_W) for water and express it mathematically in an equation.

13. Calculate:
    - H^+ conc. given the K_a, initial conc. of the acid or its salt
    - pH and pOH given the H+ or OH- conc. or vice versa
    - pH of a diprotic acid such as carbonic acid given the K values and initial conc.
    - ratio of salt to acid to prepare a specific buffer solution
    - pH at various points on a titration curve
    - number of moles or grams of a salt necessary to produce a solution with a given pH, given K

15. Define and illustrate what is meant by a buffer solution.

16. Discuss how an acid-base indicator works and is selected.

17. Define hydrolysis and write equations for such reactions.

18. Identify salts that undergo hydrolysis.

19. Predict whether salt solutions will be acidic, basic or neutral.

20. Derive the K_b expression from K_a and K_w and vice versa.

Outcome 5 *Students will be able to demonstrate an understanding of Thermodynamics*

1. Explain the difference between a spontaneous and nonspontaneous process.

2. Define entropy and the Second Law of Thermodynamics as well as give a molecular interpretation of entropy.

3. Predict net entropy change in chemical reactions.

4. Calculate entropy change in a chemical reaction from standard thermodynamic tables.

5. Calculate Gibbs Free Energy from standard thermodynamic tables.

6. Calculate equilibrium constant given Gibbs Free Energy and vice versa.

Outcome 6- *Students will be able to demonstrate an understanding of the chemistry of coordination compounds.*

1. Identify the coordination number, ligands, donor atom, coordination sphere, and chelating group.
2. Memorize the names for common ligands and chelating agents give a list.
3. Given the name write the formula or vice versa for coordination compounds.
4. Predict the type of hybridization and structure given the formula of the compound.
5. Draw diagrams for the isomers that could exist given the formula.
6. Draw crystal field diagrams, determine the CFSE.
7. List several uses of coordination compounds.

Outcome 7- *Students will be able to demonstrate an understanding electrochemistry, corrosion and batteries.*

1. Define and give examples of an electrolytic cell.
2. Diagram and label the parts of an electrolytic cell--anode, cathode, electrolyte, direction of electron flow.
3. State and apply Faraday's Law to calculate the quantity of metal obtained during electrolysis.
4. Define coulombs, (equivalent weight) and Faraday.
5. Define and give an example of a voltaic cell.
6. Diagram and label the parts of a voltaic cell (see 2 above).
7. Describe the migration of ions and current (electron) flow in a voltaic cell given the half reactions.
8. Sketch a standard hydrogen electrode, know the potential under standard conditions and what those conditions are.
9. Define standard cell potential and know the sign convention for prediction of spontaneity.
10. Use a table of reduction potentials and predict spontaneity.
11. Calculate cell potentials using the Nernst Equation.
12. Calculate the change in G and calculate K from the cell potential.
13. Describe one of the following cells in terms of electrodes, electrolyte, half reactions and direction of electron flow:
    A. dry cell b. lead storage battery c. fuel cell d. corrosion

Outcome 8- *Students will be able to demonstrate an understanding of nuclear chemistry.*

1. Students will be able to discuss the nature of radioactivity.

2. Students will be able to write the symbols for each type of radioactive particle, including appropriate mass numbers and nuclear charge.

3. Students will be able to write, complete and balance nuclear equations.

4. Students will be able to use the half-life of an isotope to determine the age of a sample.

5. Students will be able to predict the amount of a radioactive sample that will remain after a given time period, given the decay constant or half-life of the sample.

6. Students will be able to distinguish nuclear fission from nuclear fusion and predict which nuclides undergo each type of process.

7. Students will be able to distinguish α, β, and γ radiation by their reactions to an electric field, penetrating power, and relative biological effectiveness.

8. Students will be able to describe some applications of radioactive isotopes in chemistry, industry, and medicine.

9. Students will be able to describe the construction and operation of a nuclear reactor.

Outcome 9- *Students will be able to demonstrate an introductory understanding of organic chemistry functional groups.*

1. Given the name of an alkane, alkene, alkyne write the structural formula or vice versa.

2. Recognize an aromatic hydrocarbon from the structural formula.

3. Recognize functional groups such as alcohol, ester, ketone, aldehyde, ether, acid, amine, amide from the structural formula and give a use for a representative compound of each.

4. Draw the isomers for a compound given the formula.

<u>As time permits</u>:

5. Distinguish between protein, carbohydrates and lipids given a structural formula.

6. Describe what is meant by a polymer and draw a partial structural formula.

7. Describe what is meant by optical isomers.

8. Give examples of equations illustrating: esterification, substitution, addition, oxidation, reduction and condensation.

COURSE TOPICS AND CONTENT REQUIREMENTS:

1. Kinetics
    - Factors that Affect Reaction Rates
    - Reaction Rates
    - Concentration and Rate Laws
    - The Change of Concentration with Time
    - Temperature and Rate
    - Reaction Mechanisms
    - Catalysis
2. Equilibrium
    - The Concept of Equilibrium
    - The Equilibrium Constant
    - Understanding and Working with Equilibrium Constants
    - Heterogeneous Equilibria
    - Calculating Equilibrium Constants
    - Applications of Equilibrium Constants
    - Le Châtelier's Principle
3. Acids-Base Equilibrium
    - Acids and Bases: A Brief Review
    - Bronsted-Lowry Acids and Bases
    - The Autoionization of Water
    - The pH Scale
    - Strong Acids and Bases
    - Weak Acids
    - Weak Bases
    - Relationship Between K_a and K_b
    - Acid-Base Properties of Salt Solutions
    - Acid-Base Behavior and Chemical Structure
    - Lewis Acids and Bases
4. Additional Equilibrium
    - The Common-Ion Effect
    - Buffered Solutions
    - Acid-Base Titrations
    - Solubility Equilibria
    - Factors that Affect Solubility
    - Precipitation and Separation of Ions
    - Qualitative Analysis for Metallic Elements
5. Thermodynamics
    - Spontaneous Processes
    - Entropy and the Second Law of Thermodynamics
    - Molecular Interpretation of Entropy
    - Entropy Changes in Chemical Reactions
    - Gibbs Free Energy
    - Free Energy and Temperature
    - Free Energy and the Equilibrium Constant

6. Electrochemistry
    - Oxidation States and Oxidation-Reduction Reactions
    - Balancing Redox Equations
    - Voltaic Cells
    - Cell Potentials Under Standard Conditions
    - Free Energy and Redox Reactions
    - Cell Potentials Under Nonstandard Conditions
    - Batteries and Fuel Cells
    - Corrosion
    - Electrolysis
7. Transition Metals and Coordination Chemistry
    - The Transition Metals
    - Transition Metal Complexes
    - Common Ligands in Coordination Chemistry
    - Nomenclature and Isomerism in Coordination Chemistry
    - Color and Magnetism in Coordination Chemistry
    - Crystal-Field Theory
8. Nuclear Chemistry
    - Radioactivity
    - Patterns of Nuclear Stability
    - Nuclear Transmutations
    - Rates of Radioactive Decay
    - Energy Changes in Nuclear Reactions
    - Nuclear Power: Fission
    - Nuclear Power: Fusion
    - Radiation in the Environment and Living System
9. Organic Chemistry
    - General Characteristics of Organic Molecules
    - Introduction to Hydrocarbons
    - Alkenes, Alkynes, and Aromatic Hydrocarbons
    - Organic Functional Groups
    - Introduction to Biochemistry
    - Proteins
    - Carbohydrates
    - Lipids
    - Nucleic Acids

INSTRUCTIONAL METHODS:

- Lecture
- Lecture demonstrations
- Youtube videos (animations of chemical processes, chemical demonstrations)
- Laboratory experiments
- Laboratory reports
- Online Homework and Quizzing system
- Examinations
- Peer tutoring

INSTRUCTIONAL MATERIALS:

- Textbook: Chemistry: The Central Science, 12 ed. Brown, Lemay, Bursten
- Laboratory manual: In house
- Online Ebook, homework and quizzing.
- Worksheets

STUDENT REQUIREMENTS AND METHODS OF EVALUATION:

- Regular attendance in lecture, seminar and laboratory
- Reading assignments
- Quizzes
- Online homework assignments
- Exams
- Participation in classroom discussions
- Performance of laboratory experiments

Final course grade is determined as a weighted average:
Exams are 70% of the final points, 20% Laboratory, 10% homework and quizzes.

Grading Scale	
Percent	Grade
90-100	A
80-89	B
70-79	C
60-69	D
< 60%	F

OTHER REFERENCES

- Chemistry and Chemical Reactivity, Kotz 2005
- Handbook of Laboratory Safety, Steere
- Handbook of Chemistry and Physics
- Chemistry, Chang 2009
- www.acs.org
- Journal of Chemical Education
- Chemical and Engineering News

Course Competency/Assessment Methods Matrix

Course Prefix, Number and Name	Assessment Options																																
For each competency/outcome place an "X" below the method of assessment to be used.	**Assessment of Student Learning**	Article Review	Case Studies	Group Projects	Lab Work	Oral Presentations	Pre-Post Tests	Quizzes	Written Exams	Artifact Self Reflection of Growth	Capstone Projects	Comprehensive Written Exit Exam	Course Embedded Questions	Multi-Media Projects	Observation	Writing Samples	Portfolio Evaluation	Real World Projects	Reflective Journals	Applied Application (skills) Test	Oral Exit Interviews	Accreditation Reviews/Reports	Advisory Council Feedback	Employer Surveys	Graduate Surveys	Internship/Practicum /Site Supervisor Evaluation	Licensing Exam	In Class Feedback	Simulation	Interview	Written Report	Assignment
Assessment Measures – Are direct or indirect as indicated. List competencies/outcomes below.	**Direct/ Indirect**	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	I	I	I	I	D	D							
Outcome 1 - *Students will be able to demonstrate an understanding of chemical kinetics.*					X			X	X																		X					
Outcome 2- *Students will be able to demonstrate an understanding of basic chemical equilibrium.*					X			X	X																		X					
Outcome 3- *Students will be able to demonstrate an understanding of solubility equilibrium and K_{sp} calculations.*					X			X	X																		X					
Outcome 4- *Students will be able to demonstrate an understanding Acid-Base Equilibrium and related calculations.*					X			X	X																		X					
Outcome 5 *Students will be able to demonstrate an understanding of Thermodynamics.*					X			X	X																		X					
Outcome 6- *Students will be able to demonstrate an understanding of the chemistry of coordination compounds.*					X			X	X																		X					
Outcome 7- *Students will be able to demonstrate an understanding electrochemistry, corrosion and batteries.*					X			X	X																		X					

Outcome 8- *Students will be able to demonstrate an understanding of nuclear chemistry.*					X			X	X																			X				
Outcome 9- *Students will be able to demonstrate an introductory understanding of organic chemistry functional groups.*								X	X																			X				