Prepared by the Department of Natural Sciences & Applied Technology
Date of Departmental Approval: February 15, 2017
Date Approved by Curriculum and Programs: February 22, 2017 Effective: Fall 2017

1. **Course Number: CHM151 / CHM151L**
   Course Title: General Chemistry I / General Chemistry I Laboratory

2. **Description:** This course emphasizes the atomic nature of matter, fundamental laws and theories of mass and energy, the periodic classification of elements, chemical bonding, nomenclature, kinetic molecular theory applied to solids, liquids and gases, solution chemistry and descriptive chemistry. Laboratory studies reinforce the principles and concepts studied in lecture and will initiate the student to sound methods of scientific investigation. (3 class hours/ 3 laboratory hours)

3. **Student Learning Outcomes:**
   Upon successful completion of this course, students are able to do the following.
   - Use the basic vocabulary of matter and energy
   - Use the unit factor method to carry out conversions among units and apply appropriate units and significant figures to describe the results of measurements
   - Carry out calculations relating energy changes to heat absorbed or liberated and to physical and chemical changes
   - Describe the evidence for the existence and properties of electrons, protons, and neutrons and predict the arrangement of the particles in atoms
   - Describe the main features of the quantum mechanical picture of the atom
   - Use the Aufbau Principle to write the electron configuration of atoms and ions and relate the electron configuration of an atom to its position in the Periodic Table
   - Write Lewis dot representations of atoms, ions and molecules. Predict whether bonding between specified elements will be primarily ionic, covalent, or polar covalent and recognize exceptions to the octet rule
   - Recognize and use formula weights and mole relationships and interconvert masses, moles, and formulas
   - Describe the basic ideas of the valence shell electron pair repulsion (VSEPR) theory and use the VSEPR theory to predict the electronic geometry of polyatomic molecules and ions
   - Describe the hybridization of atomic orbitals in carbon to produce hybrid bonding orbitals (sp3, sp2, sp) and relate that to the molecular geometry of carbon compounds
   - Describe the basic concepts of molecular orbital (MO) theory and distinguish between bonding, antibonding, and nonbonding orbitals for homonuclear diatomic molecules and ions and determine the bond order and stability of diatomic molecules and ions
   - Describe the Periodic Table and discuss chemical periodicity of the following properties: atomic radii, ionization energy, electron affinity, ionic radii, electronegativity
   - Write balanced chemical equations to describe chemical reactions, including formula unit equations, total ionic equations, and net ionic equations
   - Assign oxidation numbers to elements
   - Express concentrations of solutions in terms of molarity, molality, and mole fractions
   - Describe the Arrhenius Theory of acids and bases
   - Complete and balance equations for acid-base reactions
   - Describe the kinetic molecular theory of gases, liquids, and solids
   - Use Boyle’s Law, Charles’ Law, Avogadro’s Law, the Combined Gas Law, the Ideal Gas Law, Dalton’s Law of Partial Pressures and Graham’s law, as appropriate, to calculate the properties and behaviors of gases
   - Use stoichiometric relationships from balanced chemical equations, solution concentrations, and molar volume relationships of gases to calculate the moles, masses, or volumes of reactants and products involved in chemical reactions
   - Use appropriate techniques in the laboratory, collect and analyze meaningful data, and present clearly and cogently written laboratory results (utilizing Standard American English).

- Work cooperatively in a small group setting to complete various laboratory exercises, following accepted lab safety practices and the written instructions provided.
- Use a variety of devices and instruments in taking laboratory measurements. Use a scientific calculator as a tool in solving a wide variety of problems.
- Explain some of the ways in which chemical principles can be applied to the problems of society in general.
- Effectively utilize appropriate quantities and units to describe physical and chemical phenomena.

4. **Credits:** 4 credits

5. **Satisfies General Education Requirement:** Natural or Physical Science

6. **Prerequisite:** MAT040 (Intermediate Algebra) or MAT110 (Algebra for Precalculus) or MAT045 (Intermediate Algebra for STEM) or satisfactory basic skills assessment scores. **Co-requesite:** ENL101 (English Composition I)

7. **Semesters Offered:** Fall, Summer

8. **Suggested General Guidelines for Evaluation:** Course grading procedures and make-up policies are detailed in a student handout. In summary, 75% of the course grade evaluation is based on achievement in the lecture portion of the course, while 25% is based on the laboratory portion of the course.

9. **General Topical Outline:**

I. Some Fundamental Concepts
  A. Introduction
    1. Chemistry
    2. Matter and Energy
    3. Laws of Conservation of Matter and Energy
    4. Chemical and Physical Properties
    5. The Classification of Matter
    6. Atoms and Molecules
    7. The Scientific Method
  B. Measurement in Chemistry
    1. Units of Measurement
    2. Conversion of Units; Dimensional Analysis
    3. Uncertainty in Measurements and Significant Figures
    4. Length and Volume
    5. Mass and Weight
    6. Density
    7. Temperature and Its Measurement
II. Chemical Equations and Reactions
  A. Symbols and Formulas
  B. Atomic Mass Units
  C. The Composition of Atoms
  D. The Periodic Table
  E. Formation of Ions
  F. Ionic and Covalent Compounds
  G. Oxidation Numbers
  H. Naming of Compounds (Nomenclature)
  I. Chemical Equations
  J. Classification of
    1. Chemical Compounds
    2. Chemical Reactions
III. Chemical Stoichiometry
  A. Atomic Mass
  B. Molecular Mass
  C. Isotopes
  D. Moles of Atoms and Avogadro's Number
  E. Moles of Molecules
  F. Percent Composition from Formulas
  G. Derivation of Formulas

- H. Solutions
- I. Mole Relationships Based on Equations
- J. Calculations Based on Equations
- K. Theoretical Yield, Actual Yield and Percent Yield
- L. Limiting Reagents

IV. Thermochemistry
- A. Heat and Its Measurement
- B. Calorimetry
- C. Thermochemistry and Thermodynamics
- D. Enthalpy Changes
- E. Hess's Law

V. Structure of the Atom
- A. Electrons, Protons, Neutrons and Isotopes
- B. Radioactivity and Atomic Structure
- C. Models of the Atom
    1. Dalton's
    2. Rutherford's
    3. Bohr's
    4. Quantum-Mechanical
- D. Atomic Spectra and Atomic Structure
- E. Orbital Energies and Atomic Structure
- F. The Aufbau Process

VI. Chemical and Physical Properties of the Elements and the Periodic Table
- A. Arrangements of Elements in the Periodic Table
- B. Electron Configuration and the Periodic Table
- C. Variation of Properties within Periods and Groups
    1. Atomic Size
    2. Ionic Size
    3. Ionization Energy
    4. Electron Affinity
    5. Metallic Character
    6. Non-metallic Character

VII. Chemical Bonding: General Concepts
- A. Ionic Bonds - Electronic Structure of Ions
- B. Covalent Bonds - Electron Sharing
- C. Polar Covalent Bonds - Electronegativity
- D. Lewis Structures
- E. Resonance
- F. Formal Charge
- G. Oxidation Numbers
- H. Using Oxidation Numbers to Write Formulas
- I. Prediction of Reaction Products

VIII. Molecular Structure and Valence Bond Theory
- A. Valence Shell Electron-Pair Repulsion Theory
- B. Predicting Molecular Structure
- C. Rules for Predicting Molecular Structure

IX Orbital Overlap Theory
- A. Valence Bond Theory
- B. Hybridization Theory

X. Molecular Orbitals
- A. Molecular Orbital Theory
    1. Molecular Orbital Energy Diagrams
    2. Bond Order
    3. Paramagnetism and Diamagnetism
- B. Molecular Orbital Diagrams for
    1. The Dihydrogen Molecule
    2. The Dihelium Molecule and Ion
    3. The Dilithium Molecule
    4. The Diberyllium Molecule
    5. The Diboron Molecule
    6. The Dicarbon Molecule

7. The Dinitrogen Molecule
8. The Dioxygen Molecule
9. The Difluorine Molecule
10. The Dineon Molecule

XI. The Gaseous State and the Kinetic-Molecular Theory
- A. The Physical Behavior of Gases
  1. The Behavior of Matter in the Gaseous State
  2. Temperature and Pressure
  3. Gas Laws
     - a. Boyle's.
     - b. Charles'
     - c. Avogadro's
     - d. Gay-Lussac's
     - e. Dalton's
     - f. Graham's
     - g. Combined
     - h. Ideal
     - i. Van der Waal's
  4. Standard Temperature and Pressure
  5. Densities and Molar Masses
- B. The Molecular Behavior of Gases
  1. The Kinetic-Molecular Theory
  2. Relationship of the Behavior of Gases to the Kinetic-Molecular Theory
  3. The Distribution of Molecular Velocities
  4. Derivation of the Ideal Gas Law from the Kinetic-Molecular Theory
  5. Deviations from Ideal Gas Behavior

XII. Solutions
- A. The Nature of Solutions
  1. Gases in Liquids
  2. Liquids in Liquids (Miscibility)
  3. Solids in Liquids
  4. Solids in Solids
  5. Gases in Gases
  6. Gases in Solids
- B. The Process of Dissolution
  1. Solubilities of Common Metal Compounds
  2. The Role of Disorder and Energy Changes in the Formation of Solutions
  3. Dissolution of Ionic Compounds
  4. Dissolution of Molecular Electrolytes
- C. Expressing Concentration
  1. Percent Composition
  2. Mole Fraction
  3. Molality
  4. Molarity