جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Basic Principles of General Chemistry - ChemS 101

Division	Physical Science and Engineering Division
Course Number	ChemS 101
Course Title	Basic Principles of General Chemistry
Academic Semester	Fall
Academic Year	2019/2020
Semester Start Date	08/25/2019
Semester End Date	12/10/2019
Class Schedule (Days & Time)	01:00 PM - 02:30 PM | Sun Thu

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Christos Chatzichristidis	CHRISTOS.CHATZICHRISTIDIS@KAUST.EDU.SA	+966128087427	4348 (Level 4), 9, Engineering Science Hall (bldg. 9)	Available to students anytime I am in my office (8:00-18:00) or email for an appointment.

Teaching Assistant(s)

Name	Email

Course Information

Comprehensive Course Description

The course offers a comprehensive survey of general chemistry. The emphasis is on basic principles of atomic and molecular electronic structure, thermodynamics, chemical kinetics and equilibrium. The course will also introduce fundamental concepts of spectroscopic characterization techniques. A list of the topics covered can be found below:

-Atoms and molecules

-Atomic theory

-Quantum theory

-Electron configuration and chemical periodicity

-Chemical Bonding

-Ionization energy and electron affinity

-Gases and the Kinetic-Molecular Theory

-Energy, heat, and work

-Enthalpy and thermodynamics

-Entropy, free energy, and equilibrium

-Governing principles of spectroscopy

By the end of the course, students should have a solid background in most aspects of general chemistry.

Course Description from Program Guide	A course covering: basic concepts of Atomic numbers, masses, isotopes, stoichiometry, atomic orbitals. Bonding in molecules: Lewis structures, resonance structures, Types of bonding interactions, Bond polarity and dipole moments, Hydrogen bonds, VB theory, hybridization, MO theory, isoelectronic molecules, aromaticity, VSEPR model. Acids, bases and solutions: Bronsted acids and bases, Lewis acid theory, Introduction to coordination complexes, stability of complexes. Reduction and oxidation: Standard reduction potentials E0, Concentration effects, complexation and precipitation vs. E0, Disproportionation. Basic spectroscopy techniques (UV/Vis, IR, NMR, X-Ray, MS).
Goals and Objectives	By the end of this course, students should be able to: •calculate binding and ionization energies for electrons •describe wave-functions (orbitals) •deduce the electron configuration of an atom from the element's position on the periodic table and vice versa •identify periodic table trends, draw Lewis structures, and use molecular orbital theory •deduce the formula and name of an ionic compound from its component ions, including polyatomic ions •explain the physical properties of ionic compounds (volatility, electrical conductivity, and solubility) in terms of their structure. •decide on the polar nature of a covalent bond based on electronegativity values •determine the enthalpy change of a reaction that is the sum of multiple reactions with known enthalpy changes •explain the effects of temperature, pressure/concentration and particle size on rate of reaction •analyze graphical and numerical data from rate experiments. •understand the connection between quantum mechanics and spectroscopy • understand how light interacts with matter and how spectroscopic methods can be adapted in many ways to extract a plethora of information (energies of electronic, vibrational, rotational states, structure and symmetry of molecules, dynamic information).
Required Knowledge	There are no formal prerequisites.
Reference Texts	Chang, R., & Goldsby, K. A. Chemistry. 11th Ed. McGraw-Hill, 2016. ISBN-13: 978-0078021510 Atkins, Peter William, and Loretta Jones. *Chemical Principles: The Quest for Insight*. 5th ed. Macmillan, 2010. ISBN: 9781429239257.
Method of evaluation	**35.00**% - Final exam **15.00**% - Quiz(zes) **10.00**% - Homework /Assignments **20.00**% - Exam 2 **20.00**% - Exam 1
Nature of the assignments	There are four components to the final grade: weekly homework assignments, two quizzes, two tests, and the final exam. The contribution of each component to the course grade is as follows: 1. Quizzes (x2) -- 15% in total 2. Tests (x2) -- 40% in total 3. Final Exam -- 35% 4. Homework -- 10% in total The two quizzes have a duration of 25 minutes and will be held at the beginning of the following Sunday lectures: Sep 29; Oct 20. The two 80-minute tests will be held during lecture time on Sunday, October 6 and Thursday, November 7. The final exam will be held on Sunday, December 8, during lecture. Problem sets will be given as graded homework. The quizzes will be based on these sets. The passing threshold for the course is an overall grade of 70%. The grading system is S(Satisfactory)/U(Unsatisfactory).
Course Policies	The students are required to attend all lectures and to take notes. Students that do not show up for a quiz, a test or the exam should expect a zero in that assessment. All quizzes, tests and the final exam are closed-book and closed-notes. Students will be provided with a formula sheet and are allowed to use calculators during exams and quizzes.
Additional Information	

Tentative Course Schedule

(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Sun 08/25/2019 Thu 08/29/2019	Introduction to the course. Significant digits, Dimensional Analysis and Stoichiometry. The importance of chemical principles. Core competencies training.
2	Sun 09/01/2019 Thu 09/05/2019	The structure of the atom: Discovery of the electron and the nucleus and the need for quantum mechanics. The wave-particle duality of light: Light as a wave, characteristics of waves; Light as a particle, the photoelectric effect.
3	Sun 09/08/2019 Thu 09/12/2019	The wave-like properties of matter. Electron Microscopy. Hydrogen atom energy levels (Binding energies of the electron to the nucleus of a hydrogen atom).
4	Sun 09/15/2019 Thu 09/19/2019	The Quantum Mechanical Description of the hydrogen atom (orbitals). Electron Configuration (general rules for assigning electrons to atomic orbitals).
5	Sun 09/22/2019 Thu 09/26/2019	***Saudi National Day - no class*** Electronic Structure and the Periodic Table (Ionization energy, Electron Affinity).
6	Sun 09/29/2019 Thu 10/03/2019	1st Quiz. Periodic trends continued (Electronegativity, Atomic and Ionic Radii and Isoelectronic Atoms) Ionic, covalent and polar covalent bonds.
7	Sun 10/06/2019 Thu 10/10/2019	1st Exam Lewis structures. Formal charge and resonance structures
8	Sun 10/13/2019 Thu 10/17/2019	The Octet Rule and its exemptions. Molecular geometry and hybridization of atomic orbitals. Gases: Pressure of a gas and the gas laws.
9	Sun 10/20/2019 Thu 10/24/2019	2nd Quiz. Introduction to Thermodynamics: Bond energy/ bond enthalpy. Calorimetry. Enthalpies of reaction. Methods to calculate enthalpies of reaction.
10	Sun 10/27/2019 Thu 10/31/2019	**Mid-semester break - No class** Spontaneous change and free energy. Entropy and free energy of formation.
11	Sun 11/03/2019 Thu 11/07/2019	The rate of a reaction. Activation energy and the temperature dependence of rate constants. 2nd Exam
12	Sun 11/10/2019 Thu 11/14/2019	Factors that affect chemical Equilibrium: Le Châtelier's Principle and its applications. Problem-solving and practising writing equilibrium constant expressions. Significant figure rules for Logs.
13	Sun 11/17/2019 Thu 11/21/2019	Solutions and Solubility. Classification of Acids and Bases
14	Sun 11/24/2019 Thu 11/28/2019	The pH of Solutions of Weak Acids and Bases. Fundamentals of Spectroscopy I
15	Sun 12/01/2019 Thu 12/05/2019	Fundamentals of Spectroscopy II Final Exam
16	Sun 12/08/2019	

Note

The instructor reserves the right to make changes to this syllabus as necessary.