《Physical Chemistry II》 Syllabus

Course Number: NANA2064

Course Name: Physical Chemistry II

Course Category: Compulsory Course

Credits/Contact Hours: 4 credits; lectures: 72 hours

Evaluation Method: (weekly quizzes+ group home works) + midterm and final comprehensive examination

Semester: 4 th semester

Prerequisites: General Physics II-1 and II-2; NANA1056 and NANA1057.
Inorganic Chemistry I and II; NANA2061
English skill for scientists NANA1046 and NANA1054

Follow-Up: NANA2065

Lecturer: Manuel E. Brito

Syllabus Author: Manuel E. Brito

Syllabus Reviewer: xxxxxxxxx

Text Book: Text book, title, author, and year; other supplemental materials

Textbook: Atkins' Physical Chemistry, 9^{th} Edition (2010), Peter Atkins and Julio de Paula, Oxford University Press.

References: 1) Physical Chemistry, 6^{th} Edition, Ira N. Levine, McGraw Hill. 2) The Law of Thermodynamics: a very short introduction, 1st Edition (2010), Peter Atkins, Oxford University Press. 3) Chemical Thermodynamics in Materials Science; from basics to practical applications, First Edition (2018), Taishi Matsushita and Kusuhiro Mukai, Springer. 4) Lecture notes.

(1) Specific Goals for the Course

The main objective is to train students in the fundamentals of equilibrium thermodynamics from the physical chemistry perspective that forms a solid base for further courses in higher education in the fields of science and technology.

This course corresponds to the first-half of "Physical Chemistry II" and it covers the basic principles of thermodynamics and relevant applications in the field of matter transformation and chemical equilibrium. The student is induced to understand and formulate the concepts that are needed for the discussion of equilibrium in chemistry. Equilibrium also includes physical change, such as fusion and vaporization, examples of phase transitions. Since the discussion turns around equilibrium thermodynamics, 1) concepts as enthalpy, entropy, heat capacity and chemical potential shall be skillfully manipulated at the end of the semester to analyze and quantify complex thermodynamics problems in the field of nanotechnology. 2) The students will reach a stage of familiarity with a unified view of equilibrium and the direction of spontaneous change in terms of the chemical potentials of substances. An important tool that enables, together with a proper literature review, the solution of complex and diverse problems at the nano-scale. 3) By combining these pieces of information, and as a final phase of the training, they should be able of give both qualitative and quantitative solution to problems extracted from recent literature in the field of nanotechnology without previous knowledge of those results. And hopefully offer innovative solutions.

Nota bene: While the main purpose of the course deals with bulk properties of the matter, the students will be also challenged to study how these properties stem from the behavior of individual atoms. This topic, however, will be fully developed in subsequent courses on quantum chemistry.

(2) Topics for the Course

- The properties of gases (Perfect gas, real gases)
- The First Law (Basic concepts, thermochemistry, state functions and exact differentials)
- The Second Law (Direction of spontaneous change; Helmholtz and Gibbs energies; combining the first and second laws; molecular interpretation of thermodynamic concepts)
- Physical transformations of pure substances (Unary phase diagrams, thermodynamic aspects of phase transitions)
- Simple mixtures (Thermodynamic description of mixtures; properties of solutions; phase diagrams of binary and ternary systems; common tangent construction; activities)
- Chemical equilibrium (Spontaneous chemical reactions; response of chemical equilibrium to external stimulus and conditions; Ellingham diagrams as important tools of analysis)
- Introduction to Statistical Thermodynamics (mainly Boltzmann statistics and its use)

(3) Assessments for the Course

Course Score = Weekly quizzes + Group Home works (CD+GHW, 40%) + Midterm Exam (ME, 30%) + Final Comprehensive Exam (FCE, 60%)

Achievement of Course Goal = ((CD+GHW) Mean Score*(CD+GHW) Weight*0.4 + ME Mean Score*ME Weight*0.3 + FCE Mean Score*FCE Weight*0.3) / (100*(CD+GHW) Weight*0.4 + 100*ME Weight*0.3 + 100*FCE Weight*0.5)

Course Goal	Quizzes + HW Weight	Midterm Exam Weight	Final Comprehensive Weight
1) Use basic knowledge in physical-chemistry and equilibrium thermodynamics to conceptualize complex chemical equilibrium problems in the field of nanotechnology. (Graduation Requirements Indicator 1-1)	0.3	0.3	0.15
2) Use basic knowledge in	0.3	0.3	0.15

physical-chemistry and equilibrium thermodynamics to analyze and quantitatively solve complex problems in the field of nanotechnology (Graduation Requirements Indicator 1-2)			
3) Be able to apply equilibrium thermodynamic principles to identify and key factors in complex problems in the field of nanotechnology. (Graduation Requirements Indicator 2-1)	0.4	0.4	0.7

Rubrics for the Course:

Course Goal	90-100 (Excellent)	75-89 (Good)	60-74 (Pass)	0-59 (Fail)
1) Use basic knowledge in basic physical-chemistry and equilibrium thermodynamics to conceptualize complex chemical equilibrium problems in the field of nanotechnology. (Graduation Requirements Indicator 1-1)	The student acquired basic understanding and knowledge in chemical thermodynamics that enable him/her to fully describe complex problems in terms of chemical equilibrium	The student acquired basic understanding and knowledge in chemical thermodynamics that enable him/her to describe complex problems in terms of chemical equilibrium	The student acquired basic understanding and knowledge in chemical thermodynamics that enable him/her to recognize complex problems in terms of chemical equilibrium	The student lacks of basic understanding and knowledge in chemical thermodynamics.
2) Use basic knowledge in physical-chemistry and equilibrium thermodynamics to analyze and quantitatively solve complex problems in the field of nanotechnology (Graduation Requirements Indicator 1-2)	The student acquired basic understanding and knowledge in chemical thermodynamics that enable him/her to fully analyze complex problems in terms of equilibrium and	The student acquired basic understanding and knowledge in chemical thermodynamics that enable him/her to analyze complex problems in terms of	The student acquired basic understanding and knowledge in chemical thermodynamics that enable him/her to analyze complex problems in terms of equilibrium and	The student lacks of basic understanding and knowledge in chemical thermodynamics.

	offer innovative solutions	equilibrium and offer quantitative solutions	offer qualitative and semi-quantitative solutions	
3) Be able to apply equilibrium thermodynamic principles to identify key factors in complex problems in the field of nanotechnology. (Graduation Requirements Indicator 2-1)	The student can apply equilibrium thermodynamics to discover and innovatively exploit new key factors found in complex problems in the field of nanotechnology.	The student can apply equilibrium thermodynamics to identify non-classical key factors found in complex problems in the field of nanotechnology.	The student can apply equilibrium thermodynamics to identify classical key factors found in complex problems in the field of nanotechnology.	The student lack of basic understanding and knowledge in chemical thermodynamics.