UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Environmental Physical Chemistry

2526-2-F7501Q051

Aims

To treat the main physical-chemical aspects related to the equilibrium distribution of compounds in various environmental compartments and extend the thermodynamic discussion to the study of non-equilibrium systems, in order to use the knowledge gained for the treatment of environmental systems.

Laboratory experiences will integrate the arguments discussed during the course.

Knowledge and understanding At the end of the course the student knows:
- the thermodynamic quantities used for the description of partition equilibria of a compound between different phases and compartments;
- the equations describing the transport processes of matter, heat and momentum;
- the stability criteria of equilibrium states and stationary states, in a linear and non-linear regime.

Applying knowledge and understanding At the end of the course the student is able to:
- predict the spontaneous evolution of the systems involved in processes of distribution of a compound between different phases and compartments and calculate the distribution at equilibrium;
- calculate the spatial and temporal evolution of species following diffusion processes;
- calculate the stability of the steady state of a system that is in conditions of non-equilibrium.

Making judgements At the end of the course the student is able to:
- apply the thermodynamic description of equilibrium systems for the study partition processes;
- apply the thermodynamic description of non-equilibrium systems (in linear and non-linear regimes) for the study of transport processes and chemical reactivity.

Communication skills Knowing how to describe in a technical report in a clear and concise manner the objectives, the procedure and the results of the laboratory experiments performed. Knowing how to present orally the topics proposed by the teacher with language properties .

Learning skills To be able to apply the acquired knowledge to different contexts from those presented during the

course, and to understand the topics covered in the scientific literature concerning the thermodynamic aspects of the processes of interest.

Contents

Partitioning equilibria; Environmental thermodynamics; Transport processes

Detailed program

Thermodynamics aspects of partitioning processes. Real systems: fugacity and activity coefficients. Partitioning processes: vapour and liquid-gas distribution. Activity coefficients and solubility in water. Partitioning of compounds between different environmental compartments and phases.

Transport processes

Thermodynamics of non-equilibrium systems. Thermodynamic equilibrium and stability criteria. Non- equilibrium systems: the linear regime and the stationary states. Criteria for stability of stationary states. Systems far from equilibrium and stability criteria. Dissipative structures

Thermodynamic description of the processes that take place on the Earth pinatea

Prerequisites

Thermodynamic of equilibrium systems

Teaching form

The course includes 4 CFU (32 hours) of lectures and 2 CFU (20 hours) in the laboratory.
-) 16 two-hour lectures, in person, delivered frontaldidatics;
-) 5 four-hour lab activities, in person, Interactive Teaching. In the laboratory experiences are realized regarding topics covered during the lectures in order to better understand the phenomenological and theoretical aspects.

Textbook and teaching resource

Lecture notes of the teacher: U. Cosentino, Chimica Fisica Ambientale

Suggested textboks

P.W. Atkins, J. de Paula Physical Chemistry, 9a edition, 2011, Oxford University Press

Rene P. Schwarzenbach, R.P, Gschwend P.M., Imboden D.M., Environmental Organic Chemistry – 2003, second edition, Wiley

D. K. Kondepudi, I. Prigogine Modern Thermodynamics: From Heat Engines to Dissipative Structures, John Wiley & Sons Inc, 1998.

A. Kleidon, Thermodynamic Foundations of the Earth System, Cambridge University Press, 2016

Semester

First semester

Assessment method

The exam consists of:
- presentation of a group technical report on laboratory experiences: evaluation of the report is carried out in terms of completeness, accuracy and clarity of exposition;
- individual oral interview on a series of course contents chosen by the students and agreed with the teacher to verify: the level of the acquired knowledge; autonomy of analysis and judgment; the student's exhibition skills.

The final grade, expressed in thirtieths with possible praise, is given by the average of the two tests.

At the request of the student, the exam can be conducted in English.

Office hours

Every day, by appointment**.**

Sustainable Development Goals

CLIMATE ACTION