UCLouvain

lbrte2101

2024

Applied hydro-biogeochemistry

4.00 credits	30.0 h + 15.0 h	Q1

Teacher(s)	Delmelle Pierre ;Gerin Patrick (coordinator) ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	Inorganic and analytical chemistry; transfer phenomena; soil science, chemical thermodynamics and kinetics; bases in biology, biochemistry, microbiology.
Main themes	The course explores the physico-chemical and (micro) biological processes that govern the functioning of aquatic and soil, natural or anthropised, (eco-)systems. It describes how the principles of thermodynamics and kinetics are applied to these systems to understand their state and their evolution, in particular taking account of biological catalysis. The course focuses on the contextualisation of theoretical knowledge by analyzing specific/ real environmental issues (eutrophic waters, wastewater treatment, soil pollutants, ...). The various factors and physico-chemical and (micro) biological processes involved in these systems are presented and analyzed, with investigation of the complexity of their interactions. The course aims to highlight the scientific background neede to develop strategies for environmental management.
Learning outcomes	**At the end of this learning unit, the student is able to :** 1 a. Contribution de l'activité au référentiel AA (AA du programme) 1.1, 1.2, 1.4 2.1, 2.2, 2.3, 2.4 3.1, 3.7 4.1, 4.2, 4.3, 4.4 6.1, 6.2, 6.4, 6.5 8.5 b. Formulation spécifique pour cette activité des AA du programme (maximum 10) At the end of this activity, the student is able to quantitatively solve a complex problem concerning the functioning or evolution of aquatic or soil ecosystems , natural or affected by man, that is conditioned by interactions between physical, chemical and biological processes. More specifically, the student is able to : - Interpret data on the characteristics of a soil or water, natural, polluted or industrial (eco)system; - Identify and explain the basic phenomena (physical, chemical, biological , transfers, thermodynamics) involved in the functioning of this system; - Propose strategies to control these phenomena with the perspective of environmental protection , pollution control or industrial production; - Choose the stoichiometric , thermodynamic and kinetic models appropriate to formalize the key processes of the problem in the adequate system of equations; - Use these models and corresponding simulation tools to calculate the evolution of state variables (eg concentrations, flux .) that characterize the system; - Based on the data and results, take a position with respect to the adequacy of the proposed solution ; - Identify the processes not described by the lectures and document autonomously these processes, in ordre to be able to explain in a report the processes and their interactions with other processes involved in the evolution of the considered (eco) systems.

Evaluation methods	The assessment will be based on: - A few assignments and tests to be completed during the course weeks individually/by team (continuous assessment). Feedback will be provided on each assignment. They are an integral part of the learning support; - An individual written (open documents) exam asking each student (i) to solve problems through the use of the tools practiced during the course, and (ii) to interpret his/her results by mobilizing the concepts discussed in class. In order to ensure a sufficient balance in the student's mastery of the different approaches covered by the course and a personal mastery of the targeted skills, the exam mark will be the geometric mean of the marks obtained for the continuous evaluation and of the exam, for each of the main parts of the course: Final_score = ([sum(p_i * N_i)]^a) * ([sum(p_j * N_j)]^b) with p_i: weighting factor for continuous assessment grades (tests and assignments), such that [sum(p_i)] = 1 N_i: mark obtained for each test/work carried out in continuous evaluation p_j: weighting factor for exam questions, such that [sum(p_j)] = 1 N_i: mark obtained for each exam question a, b: geometric weighting of grades between continuous assessment and exam, such that a+b=1 The weighting factors (p_i and p_j, a and b, >=0) will be specified according to the workload of each activity implemented during the year. The assignments can only be submitted following the calendar defined on Moodle (not submitted =0; late submission = penalty). In case of second exam session, the marks of the continuous assessment will be kept; the assignments cannot be resubmitted.
Teaching methods	The course is divided in 2 main parts, corresponding to complementary approaches - manual calculation approaches of "simple" equilibria - PHREEQC software-assisted calculation approaches of "complex" equilibria Learning activities will be based on - Lectures - Exercises: Supervised resolution of exercises, tutoring and access to exercices solutions - Assignments / tests (individual or in team; distributed during the semester) using the concepts and tools developed during the course, with feedback.
Content	The course aims at preparing students to understand the main bio-physico-chemical processes that take place in different compartments of the environment, in order to better manage these environments and resolve the problems that may arise there as a result of human activities, in a context of transition towards more sustainable human activities. <u>Lectures and exercises:</u> - Reminding of basic concepts and contextualized deeper investigation of equilibria: atmospheric gas - water, acid-base , complexation - dissolution , oxidation-reduction (electron cycles in the biosphere, redox potential of natural waters and soil) - Characterization of soil and water: biotic and physico -chemical parameters - Analysis of the functioning of environmental systems : pollution of aquatic ecosystems (pollution profile, eutrophication), background of waste water purification processes (primary, secondary , tertiary), substances dynamics in the soil profile (not reactive and reactive solutes, complexes) , chemistry and biochemistry of the rhizosphere and root. - Practical use of the PHREEQC software. - Simulation of complex physico-chemical equilibria with PHEEQC and interpretation of the results. <u>Personal work and problem solving learning </u>(tutoring by the supervisors) . Analysis of practical situations relevant to the functioning of aquatic or soil systems: development of the relevant PHEEQC scripts and simulation of equilibria, interpretation of the results, translation of the interpretations to practical recommendations. This course aims to prepare students to professional activities that involve analysis or management of aquatic, soil and organic environments. It is based primarily on the structuring and integration of knowledge of basic chemistry, (micro) biology and engineering in the previous years of the bioengineers learning programs, and their implementation to understand the functioning of the natural environment or designing technologies for soil remediation or water treatment .
Inline resources	Moodle PHREEQC (information on Moodle) Autre: Scientific journals in the field of soil and water, available though UCL libraries subscriptions
Bibliography	Ouvrages de référence (facultatifs): Werner Stumm, James J. Morgan. 1996. Aquatic Chemistry: chemical equilibria and rates in natural waters. 3rd Edition. Wiley-Interscience Publication, John Wiley and Son Inc. ISBN 0-471-51184-6, ISBN 0-471 ou Laura Sigg, Werner Stumm, Philippe Behra. 1994. Chimie des milieux aquatiques: chimie des eaux naturelles et des interfaces dans l'environnement. 2d edition. Masson. ISBN 2-225-84498-4.
Other infos	Activities following the proposed activity: Courses of effluent and soil treatments, Project in Environmental Science and Technology, master thesis. This course can be given in English (French-friendly).

Faculty or entity in charge	AGRO

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Forests and Natural Areas Engineering	BIRF2M	4		
Master [120] in Environmental Bioengineering	BIRE2M	4		
Master [120] in Chemistry and Bioindustries	BIRC2M	4		
Master [120] in Agriculture and Bio-industries	SAIV2M	4		