ERASMUS MUNDUS MASTER PROGRAMME IN SOIL SCIENCE – emiSS

2020-2021 ACADEMIC YEAR - MODULE SYLLABUS

Name of course:	
ECOCHEMISTRY OF HEAVY METALS	
ECTS	*6*
Type of Course	*Elective*
Form of Examination	*Written Examination*
Prerequisites	*Basic knowledge in the chemistry, soil science, agricultural and envirionmental science.*

Field of Study:	
Agriculture	
Education profile	*Academic*
Code of study form and level of education	*Master of Science*
Academic year/Semester	*First year/Spring Semester*
Specialization	*Agriculture*
Language of education	*English*

The lecturer module:	
The name of faculty	*Agricultural Univ. Faculty of Plant protection and Agroecology*
The name of department	*General Chemistry*

Educational outcomes:	
Description of the learning effect	
KNOWLEDGE - student knows and understands:	
1	*Student knows to evaluate the behaviour and reactions of heavy metals and metalloids in natural and polluted ecosystems*
2	*Student knows the mathematical evaluation of relationships among soil plant analyses*
3	*Student knows to select and apply appropriate remediation and management techniques for metal-polluted soil, sediments and water*
SKILLS - the graduate can	
1	*Student obtains the necessary scientific information from literature, databases or other sources*
2	*Student shows the ability to correctly interpret results and draw conclusions soil plant analyses.*

SOCIAL COMPETENCES - graduate:	
1	*Student shows activity during a discussion on various issues related to soil and plant analysis and phytoremediation of contaminated soils*
2	*Student has the competence to participate in agricultural research and discuss their results*

Course objectives and content:

This course focusses on heavy metals and metalloids in the environment. Presence, fate and management of heavy metals and metalloids, in the environment is discussed. This includes their properties, origin, behavior and dynamics in the soil-water-plant continuum. Emphasis is put on factors affecting the transfer of metals from soils or water to biota and the biomagnification in the food chain. Remediation and management options for metal contaminated water, soil, and sediments are explored. Analytical aspects are also highlighted. Practical work focuses on conducting chemical analysis of heavy metals and metalloids in water, soils and plants and interpreting the data obtained. Environmental technologies to remediate soil, sediments and water polluted by heavy metals and metalloids are discussed, as well as related legislation (soil and water quality standards), and management techniques to reduce the bioavailability and mobility of metals and metalloids in situ.

Ecochemistry of Heavy Metals		*36 hours*
Subject of lecture	*1*	*Chemical properties of heavy metals. Geochemical origin of heavy metals in soils, pedogenezis and movement in the soil profile. Heavy metals contents in sediments and water 3 h*
	2	*Source of pollution. Natural sources, anthropogenic sources (industrial plants, mining plants, heat and power, agriculture, urbanization) 2 h*
	3	*Chemical activity of heavy metals in soil and water. Effect of soil processes on behavior (retention) of heavy metals in soil - adsorption on soil components (cation exchange, specific adsorption), co-precipitation, complexing with organic matter) 4 h*
	4	*Mobility of heavy metals in soils. Influence of pH, organic matter, carbonates, clay minerals, redox potential on the behavior and chemical forms of heavy metals 3 h*
	5	*Transfer to plants and biomagnification. Heavy metals uptake by plants through absorption by the roots and the leaves. Movement of heavy metals in plants. Effect of other elements 3 h*
	6	*Influence of heavy metals on plant growth. Toxicity of metals (chemical aspect of the problem). Biologically need some elements (copper, zinc) for their development. Sensitivity of plants to micronutrient deficiencies.* *Toxicity of heavy metals - definition of toxicity and phytotoxicity assessment phytotoxicity of the metals, resistance of plants to heavy metals (indicators, accumulators, hyperaacumulators) 3 h*
	7	*Midterm exam*
	8	*Behavior of some toxic metals (Pb, Cd, Hg). Sources, chemical behavior in soils, uptake by plants, translocation in plants, toxicity 3 h*
	9	*Behavior of some toxic non-metals (As, Se).Sources, chemical behavior in soils, uptake by plants, translocation in plants, toxicity 3 h*
	10	*Chemical-analytical assessment of the content of heavy metals in soil, water and plants. Types of analysis 3 h*

11	*Opportunities and ways to reduce the phytotoxicity of heavy metals in soils. Use of biological, physical and chemical methods for purification of soil heavy metals 3 h*
12	*Phytoremediation. Use of hyperaccumulators to clean the soil of heavy metals - opportunities, problems 3 h*
13	*Standards and regulations. Legal Documents for the content of heavy metals in soils, waters, plants, foods (ISO standards) 3 h*
14	*Final exam*

The methods of verification and assessment criteria and principles	*For a positive grade: student should receive at least grade 4 on midterm exam and for final exams score should be greater than 4 (excellent is 6).*

Literature:	
Recommended Textbooks	1- *Chandra R., Dubey, N. K., Kumar,V. 2017.Phytoremediation of Environmental Pollutants. CRC Press* 2- *Hooda, P. 2010. Trace elements in soils. Wiley-Blackwell, Blackwell Publishing Ltd.* 3- *Kabata – Pendias, A. 2001. Trace elements in soil and plants, 3rd ed. CRC Press, Boca Raton, Fla.* 4- *Kabata – Pendias, A., Mukherjee, A. 2017. Trace elements from soil to human, Springer.* 5- *Prasad, M. N. V., Sajwan, K. S., Naid, R. 2019. Trace Elements in the Environment: Biogeochemistry, Biotechnology, and Bioremediation. CRC Press* 6- *Sherameti, I., Varma, A. 2015. Heavy Metal Contamination of Soils Monitoring and Remediation. Springer.*
Complementary	*Current publications in scientific journals related to course issues and some course materials supported by lecturer.*

Structure of learning outcomes:

The area of study: agricultural, soil science, environmental science, natural resources ***6 ECTS****

The structure of student activity:

Learning Activities	***Amount***	***Time (h)***	***Total work-load (h)***
Participate in lecture	*12*	*3*	*36*
Participate in midterm exam	*1*	*2*	*2*
Individual study for midterm exam	*6*	*3*	*18*
Individual study for lectures	*12*	*1*	*12*
Laboratory study	*10*	*2*	*20*
Quiz			
Assignment	*10*	*2*	*20*

Participate in final exam	*1*	*2*	*2*
Individual study for final exam	*6*	*3*	*18*
Literature critical review			
Oral exam			
Individual study for problem solution	*11*	*2*	*22*
Consultations			
Participate in researches			
Mandatory practices and internships			
	Total workload (h)		***150***

*ECTS Credits = Total Workload (Hours) / 25 (Hours/1 ECTS) = 150 / 25 = 6 ECTS

Name Surname
of Lecturer: Violina Angelova Sign:..... Date: 16.01.2020