NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

Department of Soil Science and Soil Conservation

"CONFIRMED"
Dean Agrobiology Faculty
_____ V. Kovalenko
"____" _____2024

"APPROVED"
at the meeting of the department
Soil Science & Soil Conservation
Protocol № 8 dated 24.05. 2024
Head of Department
_____ V. Zabaluiev

"REVIEWED"
Program Coordinator of "Agronomy"
Program Coordinator
_____ V. Kovalenko

PROGRAM OF THE COURSE
"Soil Science with the Basics of Geology"

Field of Study:	**20 «Agricultural Sciences and Food»**
Specialization:	**201 "Agronomy"**
Educational program:	**"Agronomy"**
Faculty:	**Agrobiology**
Developer:	**Associate Professor, PhD, Yuriy Kravchenko**

Kyiv – 2024

Description of the course
"Soil Science with the Basics of Geology"

Field of knowledge, specialization, educational program, educational degree		
Educational degree	Bachelor	
Specialization	201 Agronomy	
Educational program	"Agronomy"	
Characteristics of the course		
Type	Compulsory	
Total number of hours	210	
Number of ECTS credits	7	
Number of content modules	4	
Course project (work)	1	
Form of assessment	Exam	
Indicators of the course for full-time and part-time forms of study		
	Full time	Part time
Course (year of study)	1, 2	-
Semester	3, 4	-
Lecture classes	60 hours	-
Practical, seminar classes	-	-
Lab classes	60 hours	-
Self-study	90 hours	-
Individual assignments	-	-
Number of weekly classroom hours for the full-time form of study	4 hours	-

1. Purpose, objectives, and competencies of the course

Purpose: this course is an introductory designed course for the Bachelor student, which provides the basic concepts of all aspects of geology and soil science. It encompasses: Earth's origin; internal and external Earth's dynamics; minerals and rocks – formation, composition, diagnostics and properties changes; agronomic ores properties and application; anthropogenic influence on geologic environment. The course presents the soil composition and genesis; physical, chemical, and biological properties; soil water; classification and mapping; soil conservation; management practices; and soil fertility and productivity (soil testing, use of fertilizers and liming), soil quality assessment. The course gives practical experience as an aid in developing understanding of the minerals, rocks and soils as natural bodies, the use of which has an influence on environmental, human society and life in general.

Objectives:

1. demonstrate understanding of the theoretical basis behind geology and its related concepts;
2. observe and record geologic features and processes;
3. diagnose mineral and rock properties;
4. describe the generation and use of natural resources;
5. describe fundamental soil physical, chemical, and biological properties and processes as well as the interactions among them that
   - govern soil formation, development and differentiation,
   - determine soil suitability and capacity to perform various essential production and ecological functions, and
   - allow for sustained use, conservation, and productivity of soil.
6. utilize laboratory techniques to determine soil properties;
7. be able to relate those fundamental soil properties and processes to land use and soil management decisions and implications for soil sustainability, function, and degradation.

Acquisition of competencies:

Integrated competency (IC):

- The ability to solve difficult specialized tasks and practical problems in agronomy, including the application of theories and methods of the relevant science and is characterized by the complexity and uncertainty of conditions.

General Competencies (GC):

GC 5 – ability to use foreign language;
GC 6 – knowledge and understanding of the subject area and understanding of the professional activity;
GC 7 – ability to apply knowledge in practical situations;
GC 8 – ability to provide the safety activity;
GC 11 – striving to sustain the environmental.

Professional (special) competencies (PC):

PC 1 – ability to use the basic knowledge of general subdivisions of agrarian sciences (plant growing, farming, plant selection and seed science, agricultural chemistry, horticulture, soil science, fodder production, agrotechniques in plant growing, plant protection);
PC 2 – ability to grow, breed of agricultural crops and apply technological operations for primary products processing and storage;
PC 3 – knowledge and understanding of basic biological and agrotechnological concepts, rules and theories related to the crops and other plants growing;
PC 4 - ability to apply knowledge and understanding of physiological processes in crops to solve technological problems;
PC 5 – ability to estimate, interpret and synthesize the theoretical and practical information as well as industrial and research data in agriculture production;
PC 6 – ability to apply methods of statistical processing of experimental data related to technological and selection processes in agronomy;
PC 7 – ability to scientifically use fertilizers and plant protection chemicals, taking into account their chemical and physical properties and influence on the environment;
PC 8 - ability to solve a wide range of problems and tasks in the process during crop growing, by understanding their biological features and using both theoretical and practical methods;
PC 9 - ability to provide complex management of activities and projects, responsibility for decision making under industrial conditions.

Program learning outcomes (PLO):

PLO 4 – to compare and evaluate modern scientific and technical achievements in the field of agronomy;
PLO 5 – to conduct a literature search in Ukrainian and foreign languages and analyze the received information;
PLO 6 – to demonstrate the knowledge and understanding of fundamental disciplines to the extent necessary to possess relevant skills in the field of agronomy;
PLO 9 – to provide at the operational level the methods of: observation, description, identification, classification, as well as the cultivation of the objects and maintain the stability of agrocenoses with the conservation of natural diversity;
PLO 10 – to analyze and integrate knowledge from general and special professional training to the extent necessary for specialized professional work in the field of agronomy;
PLO 11 – to initiate the prompt and expedient solutions of the production problems according to zonal conditions;
PLO 13 – to design and organize activities for the high-quality agricultural products growing in accordance with current requirements;
PLO 14 – to integrate and improve production processes of crop growing according to current requirements;
PLO 16 – to organize effective and safe working conditions.

2. Program and structure of the course for full time students

3.1. Course program

Module 1. General Geology

1. What is soil? Introduction of the course: A concept about the soil. Soil as a natural body, medium for plant growth. The soil functions as a component of biogeocenosis, lithosphere. Structural levels of a soil organization. A place, functions and role of soil in nature. Small biological and big geological cycles.
2. Internal and external spheres of the Earth: lithosphere, asthenosphere, oceanic and continental crust, subduction zones, lithospheric plates, isostasy. Gravitation, magnetic, thermal and other geophysical fields.
3. Magmatic, metamorphic and sedimentary processes. A concept about a magma. Intrusive magmatism. Effusive magmatism is volcanic magmatism. Metamorphism, chemical and mineralogical changes during metamorphism. General life history of sediment: Weathering, Transport, Deposition, Cementation (diagenesis, katagenesis, lithification). Depositional environments: Continental (fluvial, eolian, lacustrine, glacial), Marine (continental shelf and reef, abyssal plain), Transitional (deltaic, beaches).
4. Endogenic geological processes. Theory of plate tectonics. Types of Stress. Ductile (Plastic) deformations of rocks. Elements of fold. Types of volcanoes. Cause of earthquakes. Geographical distribution of earthquakes. Classification and types of earthquakes.
5. Weathering processes and soil formation. Weathering types and factors, that cause its. Agents of physical weathering. Oxidation, reduction, hydration, dehydration, hydrolysis, kaolinitization, montmorilonitization. Weathering influence on relief. Core of weathering as a natural complex of mountains, relief, climate which was made historically.
6. Exogenic geological processes. Geological activity of wind. Movement of sediment. Types of Mass Wasting (Heave, Creep, Solifluction, Slumps, Earthflows, Debris slides, Rockfalls, Debris flows, Mudflows, Rockslides). Floods and floodplain deposits. The alluvium origin, its lithologic description. Sediments of lakes (terrigenous, chemical, biogenic). Seas deposits in: littoral shelf, bathyal zone, abyssal zone. Glacial Deposits, Glacial Sediments: till, moraines, drumlins, glacial erratics, outwash plains, ozy, kames, kettles, eskers, dropstones. Springs, water wells, and artesian systems. Recharge of groundwater.

Module 2. General Soil Science 1.

7. Soil formation and soil processes. Soil forming factors, regimes and processes. Macro-, meso- and micro processes within a solum. General diagram of soil formation. A concept of the primary, medium and mature phases of soil formation. The energy and particles distribution in a soil profile. A concept about the soil horizons. Types of soil profiles. Soils evolution and degradation.
8. Soil classification. A concept about soil classification, nomenclature and diagnostics. Classification problems in soil science. Principles, goals and values of soils classification. History of soils classification development.
9. Soil taxonomy and morphology. Taxonomy units of genetic classification: type, subtype, genious, spieses, soil texture, lithologic seria. Climatic, hydrological and biological principles of soil diagnostics. Morphologic-genetic, chemical and other indexes of soil diagnostics.
10. Overview of soil properties and ecosystem functions. These soil functions include: air quality and composition, temperature regulation, carbon and nutrient cycling, water cycling and quality, natural "waste" (decomposition) treatment and recycling, and habitat for most living things and their food.
11. Soil physical properties 1. Texture, structure and soil water categories. Classification of soil texture, particles and their properties. Mechanical analysis. The field and pipet method. Stokes' Law. Texture of Ukrainian soils. Extent of soil profile differentiation by texture, granulometric factor of soil aggregation. Binomial and trinomial, American classifications of soil texture, their principles, differences and characteristic features. General genetic, agronomical and ecological values of soil texture.
12. Soil ecology 1. Soil communities, plants, macro- and microanimals. The zoogeographic distribution of soil fauna, taxonomic level of the group, dispersal and the size of the organism. Species of micro- and mesofauna, the separation of ecologically equivalent species groups is discussed in relation to soil moisture and vegetation types. The organization of microarthropod communities. Mite species diversity and microhabitat diversity.
13. Soil ecology 2. Fungi, bacteria and archaea, microbial interactions. Bacteria, archaea and fungi role in biogeochemical processes. However, little is known about their community structure, dynamics and interactions in landscapes.

14. Soil organic matter 1. Sources of SOM and its composition. OM remains quantity and quality in different ecosystems. SOM Determination. A classification scheme for soil organic matter. Specific and non-specific organic/humus substances. Structure and properties of humus (humic substances). Interactions of humic substances with mineral components.
15. Soil organic matter 2. Types of humus. SOM status after L.O. Grishina and D.S. Orlov. Organic matter in different soil types. Humification. Balance of SOM.

Module 3. General Soil Science 2.

16. Soil colloids. A concept about the soil colloids. Structure, composition, origin, classification and properties of soil colloids. Colloidal state, coagulation and peptization. Adsorption, electro kinetics, protective and other properties of soil colloids, their influence on soil formation. A role of soil colloids in the formation of soil fertility. Ecological value of soil colloids.
17. Sorption, cation and anion exchange. Mechanical, physical, exchangeable, chemical, biological retention. A role of calcium, iron, sodium and other cations and dispersion matters in the processes of soil absorption. A role of absorbed cations in soil formation. Saturated and unsaturated soils with bases and its dependence on cations composition. The energy of ions sorption. Cation exchange capacity. Cation composition of Ukrainian soils.
18. Soil acidity and alkalinity. Sources of soil acidity. pH reaction and its ranges. Active and reserve acidity and methods its determination. Base exchange capacity. Chemical amendment of acid soils, liming rate. Active and potential alkalinity. Extent of soil sodicity. Determination of the extent of soil sodicity and calculation of gypsum rates. Resistance of agricultural crops to soil acidity and sodicity.
19. Soil salinity. Salt-affected soils. Soil Extract Analysis. The concentration of soil colloids. Toxic salts. Extent and type of soil salinity. The oxidation and reduction processes in Soil solution. Redox potential. T.Clark index. Salt tolerance of plants. Secondary salinity or sodicity. Management of salt-affected soils.
20. Soil physical properties 2. Soil structure. soil density, pore space, impacts of tillage. Soil aggregates classification. Agronomically favorable structural aggregates. Aggregates within different soils, soil horizons. Dry and wet aggregate analysis. Particle density, bulk density, determination and analytical procedure. Optimum values of the bulk density. Soil porosity. Total, aeration, capillary porosity determination. Soil's resistance to tillage. Soil's physical maturity for tillage. Soil hardness.
21. Soil water. A role of water in plant growing, vital functions of animals and microorganisms. State, forms of connection and category of water in soil. Features of connection of water with the solid phase of soil, chemical matter, molecules and ions. Soil water and water-related properties. States, forms, categories of soil water and its properties. Field, capillary, maximum adsorbing, full, available water capacity of soils. Non-available water. Soil water potential.
22. Soil air and temperature. Gaseous phase of the soil. Composition of soil air. CO2 dynamics. Convection, diffusion. Air penetrability. Anaerobiosis. Air regime and its regulation. Energy exchange processes. Radiation, convection, conduction. Heat adsorbing capacity, albedo, heat capacity, specific heat capacity. Heat conductivity, heat regime of soil. Thermal regimes.
23. Soil productivity and its evaluation. Essential Criteria. The typical soil grades in points. Etalon of grades. The prices of the grades of soil evaluation. Weighted average grade. Correction coefficients. Soil grade. Soil class. Land Area Evaluation.

Module 4. Soil Geography.

24. Soils of the Forest zone. Soddy-Podzolic, Sod, Swampy soils. Classification, genesis, properties, management.
25. Soils of the Forest-Steppe zone. Grey forest soils, Podzolized, Leached, Typical Chernozems. Classification, genesis, properties, management.
26. Soils of the Steppe zone. Ordinary and Southern Chernozems. Classification, genesis, properties, management.
27. Soils of the Arid-Steppe zone. Chestnut soils. Classification, genesis, properties, management.
28. Saline soils. Solonchak, solonetz, solod. Classification, genesis, properties, management.
29. Alluvial and meadow soils. Meadow-chernozems, meadow, soddy, swampy, alluvial soils. Classification, genesis, properties, management.
30. Soil erosion, degradation and productivity management.

3.2. Course structure.

Names of content modules and topics	Number of hours						
	Full time form						
	weeks	total	including				
			l	p	lab	ind	self
Content Module 1. General Geology							
Topic 1. Introduction to course. What is soil?	1		2	-	-	-	-
Topic 2. Internal and external spheres of the Earth.	2		2	-	-	-	-
Topic 3. Magmatic, metamorphic and sedimentary processes	3		2	-	-	-	-
Topic 4. Endogenic geological processes.	4		2	-	-	-	-
Topic 5. Weathering processes and soil formation	5		2	-	-	-	-
Topic 6. Exogenic geological processes.	6		2	-	-	-	-
Total for content module 1		24	12	-	12	-	-
Content Module 2. General Soil Science 1							
Topic 7. Soil formation and soil processes	7		2	-	-	-	-
Topic 8. Soil classification	8		2	-	-	-	-
Topic 9. Soil taxonomy and morphology	9		2	-	-	-	-
Topic 10. Overview of soil properties and ecosystem functions	10		2				
Topic 11. Soil physical properties 1. Texture, structure and soil water categories	11		2				
Topic 12. Soil ecology 1. Soil communities, plants, macro- and microanimals	12		2	-	-	-	-
Topic 13. Soil ecology 2. Fungi, bacteria and archaea, microbial interactions	13		2	-	-	-	-
Topic 14. Soil organic matter 1	14		2	-	-	-	-
Topic 15. Soil organic matter 2	15		2	-	-	-	-
Total for content module 2		36	18	-	18	-	-
Content Module 3. General Soil Science 2							
Topic 16. Soil colloids	16		2	-	-	-	-
Topic 17. Sorption, cation and anion exchange	17		2	-	-	-	-
Topic 18. Soil acidity and alkalinity	18		2	-	-	-	-
Topic 19. Soil salinity	19		2	-	-	-	-
Topic 20. Soil physical properties 2. Soil structure. soil density, pore space, impacts of tillage	20		2	-	-	-	-
Topic 21. Soil water	21		2	-	-	-	-
Topic 22. Soil air and temperature	22		2	-	-	-	-
Topic 23. Soil productivity and its evaluation.	23		2	-	-	-	-
Total for content module 3		32	16		16		
Content Module 4. Soil Geography							
Topic 24. Soils of the Forest zone	24		2				-
Topic 25. Soils of the Forest-Steppe zone	25		2				-
Topic 26. Soils of the Steppe zone	26		2				-
Topic 27. Soils of the Arid-Steppe zone	27		2				-
Topic 28. Saline soils	28		2				-
Topic 29. Alluvial and meadow soils	29		2				-
Topic 30. Soil erosion, degradation and productivity management	30		2				-
Total for content module 4		28	14	-	14		-
Course project (work) on Soil Science						1	
Total hours		121	60		60	1	

3. Laboratory class topics

Topic title	Number of hours
1. The general mineral properties and crystallography	2
2. Soil minerals	4
3. The general rock properties and their formation	2
4. Rocks as natural formations	2
5. Quaternary deposits and agronomic ores	2
6. Lab Safety. Soil sampling	2
7. Forms (categories) of soil water.	2
8. Soil hygroscopic moisture determination.	2
9. Soil granulometry and particle size distribution.	2
10. Methods of soil texture determination.	2
11. International pipette and hydrometer methods.	4
12. Soil organic matter determination.	2
13. Humus balance	2
14. Cation exchange capacity determination.	2
15. Soil acidity and its amendment.	2
16. Active and exchangeable acidity determination.	2
17. Hydrolytic acidity determination.	2
18. Soil alkalinity and salinity.	2
19. Soil extract analysis.	2
20. Reclamation of saline soil.	2
21. Soil productivity assessment.	2
22. Soil distribution in Ukraine	2
23. Forest zone soils properties and management	2
24. Forest-Steppe zone soils properties and management	2
25. Steppe zone soils properties and management	2
26. Arid-Steppe zone soils properties and management	2
27. Saline soil properties and management	2
28. Alluvial and meadow soils properties and management	2

4. Independent work topics

№	Topic title	Number of hours
1	Working with geological processes	15
2	Soil Solids and Soil Organic matter	15
3	Soil Productivity	15
4	Soil Survey	15

5. Means of diagnosing learning outcomes:

- examination;
- test;
- module tests;
- course work;
- defense of laboratory and practical work.

6. Teaching methods

- oral method (lecture, discussion)
- practical method (laboratory, field trials)
- visual method (illustration method, demonstration method);
- work with professional and methodological literature (note-taking, thesis, reviewing, writing an abstract);
- video method (remote, multimedia, web-based, etc.);
- independent work (completion of tasks);
- individual research by students.

7. Forms of assessment

- exam;
- test;
- oral and written examination;
- module tests;
- abstracts, essays;
- defence of laboratory work;
- presentations and talks at scientific events.

8. Distribution of grades received by students

The assessment of knowledge of higher education applicants is based on a 100-point scale and is converted into national grades in accordance with Table 1 of the current 'Regulations on Exams and Tests in NUBiP of Ukraine'

Student rating, points	National grade based on exam results	
	Exams	Credits
90-100	Excellent	Passed
74-89	Good	
60-73	Satisfactory	
0-59	Unsatisfactory	Not passed

In order to determine the rating of a student (listener) in the discipline R_{dis} (up to 100 points), the rating from the exam R_{ex}(up to 30 points) is added to the rating of a student's academic work R_{aw} (up to 70 points): $R_{dis} = R_{aw} + R_{ex}$.

9. Educational and methodological support

- e-learning course of the discipline: https://elearn.nubip.edu.ua/course/view.php?id=2702 and https://elearn.nubip.edu.ua/course/view.php?id=3304.
- lecture notes and presentations (in electronic form);
- textbooks, manuals, lab notes;
- methodological materials for the study of the discipline for full-time and part-time students;
- summer training programme of the discipline.

10.Recommended sources of information

Textbooks:

1. Petrenko L., Berezhniak M., Kravchenko Y., Kozak V., Berezhniak E. Soil Science with Elements of Geology. K.: ЦП ''Komprint", 2020. 702 p.
2. Kravchenko Y.S. Geology with the principles of Geomorphology. Part 1. Dynamic Geology. Київ, ТОВ "Центр ІТ». 2019. 142 p.
3. Brady, N.C. and R.R. Weil. 2021. Elements of the Nature and Properties of Soils, 15th Edition. Pearson Prentice Hall.
4. Бережняк М. Ф., Якубенко Б. Є., Тонха О. Л., Чурілов А. М., Сендзюк Р. В., Бережняк Є. М. Ґрунтознавство з основами геоботаніки. Навчальний посібник. Київ: Вид-во "Ліра". 2019. 636 с.

Laboratory books:

1. Petrenko L., Berezhniak M., Kravchenko Yu., Tonkha O., Berezhniak Ie., Bykova O. Soil Science: Practical Methods Manual. NUBIPU Publishing Center, Kyiv, 2023. 429 p.
2. Tomaizeh S. Soil Science Manual Lab. Hebron University, Soil and Irrigation Department.2020.56 p.