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Информация о владельце:
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**Federal State Autonomous Educational Institution for Higher Education
PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA (RUDN University)
named after Patrice Lumumba**

Institute of Environmental Engineering

COURSE SYLLABUS

MODERN REMEDIATION TECHNOLOGIES

**Recommended by the Didactic Council for the Education Field for the
specialization:**

05.04.06 "Ecology and nature management"

**The course instruction is implemented within the professional education
programme of higher education:**

«Integrated Solid Waste Management»

1. COURSE GOAL(s)

The discipline "Modern Remediation Technologies" is part of the Master's program "Integrated Municipal Solid Waste Management" in the field of study 05.04.06 "Ecology and Environmental Management" and is studied in the 3rd semester of the 2nd year. The discipline is delivered by the Department of Rational Nature Management. The discipline consists of 3 sections and 10 topics and is aimed at an in-depth study of methods for solving problems caused by accumulated environmental damage sites.

The aim of the discipline is to train specialists capable of managing projects for the restoration of accumulated damage sites, applying modern methods of processing and interpreting environmental information, and creatively using fundamental and applied knowledge to develop and implement effective solutions in the field of environmental rehabilitation.

As a result of completing the course, the student must:

Know:

- Technological solutions for the remediation of contaminated areas;
- General issues of work on rehabilitation and management of disturbed lands;
- Classification of disturbed lands according to technogenic relief and area;
- Types of natural-technogenic landscapes;
- Stages of remediation of natural and technogenic landscapes.

Be able to:

- Correctly classify accumulated environmental damage sites;
- Reasonably select remediation methods for accumulated environmental damage sites;
- Evaluate the environmental and economic efficiency of the measures taken.

Possess skills in (Own):

- Methods of developing schemes for the integrated remediation of disturbed lands and water bodies;
- Skills in selecting the best available technology (BAT) for eliminating environmental damage.

2. REQUIREMENTS FOR COURSE OUTCOMES

The course implementation is aimed at the development of the following competences:

Competence code	Competence descriptor	Competence formation indicators (within this course)
GC -2	Capable of managing a project at all stages of its life cycle	GC -2.1 Has a systematic understanding of the theoretical and methodological foundations of environmental regulation;
PC-2	The ability to creatively apply knowledge of fundamental and applied sections of special disciplines within the Master's program in scientific and production-technological activities.	PC-2.1 Capable of assessing the natural, technogenic, socio-economic, demographic, and medico-biological situation, and of conducting searches for cultural heritage objects within the territory under investigation.

PC-4	the ability to use modern methods of processing and interpreting environmental information when conducting scientific and industrial research	PC-4.1 Know the role and limitations of the application of statistical methods in scientific and practical research; PC-4.2 Know computer tools for processing statistical data and solving statistical problems;
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3. COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

Discipline *Nature Protection and Accumulated Environmental Damage (AED) Elimination Tools / Инструменты защиты окружающей среды и ликвидации накопленного ущерба* refers to the Variative part of the curriculum.

Within the higher education programme students also master other disciplines (modules) and / or internships that contribute to the achievement of the expected learning outcomes as results of the course.

Table 3.1 *The list of the higher education programme components that contribute to the achievement of the expected learning outcomes*

Competence code	Competence descriptor	Previous courses/modules, internships*	Subsequent courses/modules, internships*
GC -2	Capable of managing a project at all stages of its life cycle	Research Work; Work Experience Internship;	Pre-Graduation Practice;
PC-2	The ability to creatively apply knowledge of fundamental and applied sections of special disciplines within the Master's program in scientific and production-technological activities.	Environmental Impact Assessment (EIA) of SWM objects; Research Work; Work Experience Internship;	Pre-Graduation Practice;
PC-4	the ability to use modern methods of processing and interpreting environmental information when conducting scientific and industrial research	IT in Ecology and Natural Resources Management; Research Work;	Pre-Graduation Practice;

4. COURSE WORKLOAD AND ACADEMIC ACTIVITIES

The total workload of the discipline is **3** credit units.

Table 4.1. Types of academic activities during the period of the HE program(me) mastering

Types of academic activities	Total hours	Semester(s)			
		1	2	3	4
<i>Contact academic hours</i>	<i>54</i>			<i>54</i>	

Lectures	18			18	
Lab works					
Seminars (workshops/tutorials)	36			36	
<i>Self-study</i>	42			42X`	
<i>Evaluation and assessment (exam; pass/fail grading)</i>	12			12	
The total course workload	hours	108		108	
	credits	3		3	

5. COURSE CONTENT

Table 5.1. Course Modules and Contents

Title of Course Modules		Content	Types of academic activities
1.	Introduction	The main sources of accumulated environmental damage and the features of its impact on the environment.	L, S
		Foreign experience in the elimination of objects of accumulated harm to the environment The scale of accumulated harm and the experience of land rehabilitation in Europe and the USA.	
2	Classification of AED objects	Approaches to the classification of objects of accumulated environmental damage. Assignment criteria	L, S
		Classification of technological solutions (methods) for the rehabilitation of objects of accumulated harm.	
3	Stages of restoration of natural-technogenic landscapes. Examples of the most dangerous objects.	Stages of restoration of natural and technogenic landscapes	L, S
		Formation of vegetation cover on dumps and artificial reservoirs	
		Requirements for the reclamation of lands disturbed during the construction and operation of linear structures	
		Peculiarities of Rehabilitation of Certain Objects of Accumulated Damage to the Environment AED and Specific Territories	L, S
		Restoration of water bodies	
		Features of reclamation of MSW landfills as objects of accumulated harm	

6. CLASSROOM EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS

Table 6.1. Classroom equipment and technology support requirements

Classroom for Academic Activity Type	Classroom equipment	Specialized educational / laboratory equipment, software and materials for mastering the course (if necessary)
Lecture	Classroom, equipped with a set of specialized furniture; whiteboard; a set of devices includes portable multimedia projector, laptop, projection screen, stable wireless	Classroom, equipped with a set of specialized furniture; whiteboard; a set of devices includes portable multimedia projector, laptop, projection screen, stable wireless Internet connection.
Seminars	Classroom, equipped with a set of specialized furniture; whiteboard; a set of devices includes portable multimedia projector, laptop, projection screen, stable wireless	Software: Microsoft Windows, MS Office / Office 365, MS Teams, Chrome (latest stable release), Skype. Microsoft Windows 7 corporate. License No. 5190227, date of issue March 16, 2010 MS Office 2007 Prof , License # 6842818, date of issue 09/07/2009
Computer Lab	Computer Lab for conducting classes, group and individual consultations, current control and intermediate certification, equipped with personal computers (in the amount of 12), a board (screen) and technical devices of multimedia presentations.	No
For Self-Study	Classroom for self-study (can be used for seminars and consultations), equipped with a set of devices includes laptop, stable wireless.	No

7. RECOMMENDED SOURCES FOR COURSE STUDIES a)

Main reading:

1. Niyitanga Evode, Sarmad Ahmad Qamar, Muhammad Bilal, Damià Barceló, Hafiz M.N. Iqbal, Plastic waste and its management strategies for environmental sustainability, Case Studies in Chemical and Environmental Engineering, Volume 4, 2021, <https://doi.org/10.1016/j.cscee.2021.100142>
- 2 D.M. Hamby SITE REMEDIATION TECHNIQUES SUPPORTING ENVIRONMENTAL RESTORATION ACTIVITIES: A REVIEW University of Michigan Ann Arbor, MI 48109-2029 U.S.A 37p <https://www.eni.com/assets/documents/eng/enirewind/remediation/vademecumeng.pdf>
3. Remediation Technologies Handbook <https://www.eni.com/assets/documents/eng/enirewind/remediation/vademecum-eng.pdf> 4 Practice Guide for Investigation and Remediation of Contaminated Land Environmental Protection Department The Government of the Hong Kong Special Administrative Region 2023 75p, https://www.epd.gov.hk/epd/sites/default/files/epd/gn_pdf/GN2014P244-2011ce.pdf

5. Ankur Rajpal, Moharana Choudhury, Srijan Goswami, Arghya Chakravorty, Vimala Raghavan Waste Management and Treatment Advances and Innovations 1st Edition CRC Press 2024, 346 p, <https://doi.org/10.1201/9781003258377>
6. Waste Treatment in the Biotechnology, Agricultural and Food Industries Handbook of Environmental Engineering Lawrence K. Wang, Mu-Hao Sung Wang, Yung-Tse Hung Springer Cham, 2022 DOI <https://doi.org/10.1007/978-3-031-03591-3>

b) Additional reading

- 1 Соловьянов А. А., Чернин С. Я. Ликвидация накопленного вреда окружающей среде в Российской Федерации. — М.: Наука РАН, 2017 — 456 с
- 2 Henrik Haller Soil Remediation and Sustainable Development- Creating Appropriate Solutions for Marginalized Regions Faculty of Science, Technology and Media Thesis for Doctoral degree in Ecotechnology and Environmental Science Mid Sweden University Östersund, 2017-06-15 <https://www.divaportal.org/smash/get/diva2:1094867/FULLTEXT02.pdf>
- 3 Hemen Sarma • Sanket Joshi Land Remediation and Management: Bioengineering Strategiesm Springer, 2023-,411 p <https://doi.org/10.1007/978-981-99-4221-3> 4
Stein, Alfred & Kerle, Norman. (2008). Environmental Remediation. 10.1002/9780470061596.risk0317 .
- 5 Xinyue Liu, Weijun Qi, Shuang Cui, Lianghe Lv, Jianyu Jiang, Jing Jiang, Ziyue Zhu A Comparison of Different Remediation Technologies of Contaminated Agricultural Soils E3S Web of Conferences , 03018 (2023) ICEMEE 2023 <https://doi.org/10.1051/e3sconf/202340603018>

Internet-based sources

1. ELS of RUDN University and third-party ELS, to which university students have access on the basis of concluded agreements:

- RUDN Electronic Library System - RUDN EBS <http://lib.rudn.ru/MegaPro/Web>
- ELS "University Library Online" <http://www.biblioclub.ru>
- EBS Yurayt <http://www.biblio-online.ru>
- ELS "Student Consultant" www.studentlibrary.ru
- EBS "Lan" <http://e.lanbook.com/>
- EBS "Trinity Bridge"

2. Databases and search engines:

- electronic fund of legal and normative-technical documentation <http://docs.cntd.ru/>
- Yandex search engine <https://www.yandex.ru/>
- Google search engine <https://www.google.ru/>
- abstract database SCOPUS <http://www.elsevierscience.ru/products/scopus/>

8. MID-TERM ASSESSMENT AND EVALUATION TOOLKIT

Evaluation materials and a point- rating system* for assessing the level of competence formation (part of competences) based on the results of mastering the discipline **Nature Protection and Accumulated Environmental Damage (AED) Elimination Tools** are presented in the Appendix to this course syllabus.

DEVELOPER:

Associate Professor of the NM

Kapralova D.O.

Department

Position	Signature	Name, Surname
HEAD OF DEPARTMENT: Director of the NM Department		Kucher D.E.

Position	Signature	Name, Surname
HEAD OF PROGRAMME: Associate Professor of the NM Department		Kapralova D.O.

Position	Signature	Name, Surname
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Department Environmental Management

APPROVED

Department meeting protocol No _____,

Dated

day, month,

year

Head of Educational Department

_____ (Kucher D.E.)

signature

ASSESSMENT TOOLKIT

for the course

Modern remediation technologies / Современные технологии рекультивации

course title

05.04.06 "Ecology and nature management"

field of studies / speciality code and title

«Integrated Solid Waste Management» higher

education programme profile/specialisation title

master

graduate's qualification (degree)

Passport to Assessment Toolkit for Course **Modern remediation technologies / Современные технологии рекультивации**

Field of Studies / Speciality 05.04.06 "Ecology and nature management"

code

title

Course: Modern remediation technologies / Современные технологии рекультивации

Competences (competences in part) under assessment	Course module under assessment	Course topic under assessment	Tools to assess higher education programme mastering level							Points for topic	Points for module	
			Class work					Self-studies				Exam/Pass- fail assessment
			Quiz	Test	Report	Seminar	Lecture	Homework	Calculation and graphic work			
GC -2 PC-2 PC-4	Module 1: Introduction	Topic 1: The main sources of accumulated environmental damage and the features of its impact on the environment	1	2		0,5	0,5	5		2	6	11

		Topic 2: Foreign experience in the elimination of objects of accumulated harm to the environment The scale of accumulated harm and the experience of land rehabilitation in Europe and the USA	1	1		0,5	0,5			2	5	
GC -2 PC-2 PC-4	Module 2: Classification of AED objects	Topic 1: Approaches to the classification of objects of accumulated environmental damage. Assignment criteria	1	2		0,5	0,5			1	5	20
		Topic 2: Classification of technological solutions (methods) for the rehabilitation of objects of accumulated harm	1	2		0,5	0,5	5		2	11	
		Topic 3: Classification of disturbed lands according to technogenic relief and area. Types of naturaltechnogenic landscapes.	1	2		0,5	0,5			2	6	
GC -2 PC-2 PC-4	Module 3: Stages of restoration of naturaltechnogenic landscapes. Examples of the	Topic 1: Stages of restoration of natural and technogenic landscapes	2	2		0,5	0,5			1	6	
		Topic 2: Formation of vegetation cover on dumps and artificial reservoirs	2	2	10	0,5	0,5	5		1	21	

	most dangerous objects	Topic 3: Requirements for the reclamation of lands disturbed during the construction and operation of linear structures	2	1		0,5	0,5			2	6	
GC -2 PC-2 PC-4		Topic 4: Peculiarities of Rehabilitation of Certain Objects of Accumulated Damage to the Environment AED and Specific Territories	2	2		0,5	0,5			1	6	
		Topic 5: Restoration of water bodies	2	2		0,5	0,5		5	1	11	
		Topic 6: Features of reclamation of MSW landfills as objects of accumulated harm	2	2		0,5	0,5	5	5	2	17	
Total			17	20	10	5,5	5,5	10	20	17	100	

Passport to Assessment Toolkit for Course **Modern remediation technologies / Современные технологии рекультивации**

course title

QUESTION CARD No

QUESTION 1 Wastes that are generated during the enrichment of mined minerals

QUESTION 2 Type of reclamation intended for preliminary preparation of disturbed areas for various uses

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Developer _____ (Kapralova D.O.)
signature

Head of Educational Department _____ (Kucher D.E.)
signature

_____ day,
month, year

Note * Practice case/task inclusion is subject to the teacher's discretion.

The set of exam question cards is complemented by the assessment criteria developed by the teacher and approved at the department meeting.

Assessment criteria:

(in compliance with the legal regulations in force)

Test question examples

- 1) The most important criterion for establishing the sequence of actions for the liquidation of a specific object of AED:
 - A) the level of environmental safety
 - B) area of the Object
 - C) the mass of accumulated production and consumption waste
 - D) remoteness of the Object from the residential area
- 2) What is the purpose of processing metal-containing sludge?
 - a) - saving electrical energy
 - b) -increasing the efficiency of industry
 - c) -- improvement of the environmental situation
 - d) - to create additional jobs.
- 7) The components of waste rubber products (RTI) include:
 - a) - oil b) - methane
 - c) - pine oil
 - d) - rubber.
- 8) How is coal preparation waste used?
 - 1) - as a mineral fertilizer
 - 2) - as fuel
 - 3) - as an element of building materials
 - 4) - as an element in the manufacture of furniture.
- 9) What methods relate to the thermal processing of waste.

- a) - pyrolysis
- b) - extraction
- c) - leaching

The set of exam question cards is complemented by the assessment criteria developed by the teacher and approved at the department meeting.

Assessment criteria:

(in compliance with the legal regulations in force)

The assessment of all results of mastering competencies is carried out in accordance with the scale of the international point-rating system ECTS. In accordance with the calculated grading system, the student gains the required points.

Work in class: depends on the complexity of the topic.

The grade is given for attendance and active work at a seminar or lecture (lectures are held in an interactive form) - answers to current questions, notes, discussion. The student is present at the lesson, participates in the discussion, does not hesitate to answer questions - maximum score. The student is absent or the task is not prepared - 0 points.

Tasks of Self-studies: - acquisition of skills of independent practical work in the recommended software and application of various research methods; - developing the ability to independently and critically apply the material being studied. The SR technology should ensure the acquisition of knowledge, the consolidation and systematization of knowledge, the formation of skills and abilities. The proven technology is characterized by an algorithm that includes the following logically related student actions: - reading a text (textbook, manual, lecture notes); - note-taking of the text; - problem solving and exercises; - answers to control questions;

Final certification: A student is considered to have successfully passed the milestone or final certification if the total score for all activities at the time of certification exceeds 50% of the maximum possible score (lecture work, practical assignment, tests).

The final grade for the semester is added up as the sum of points for all types of student activities (*see toolkit passport) and can reach a maximum of 83 points.

The final test is given by the student voluntarily, if he scored the minimum possible score for certification - 51 points. In other cases, the exam/pass/fail assessment is mandatory and is estimated at a maximum of 17 points, as a result, the total score is derived taking into account the result of passing the test and the final grade corresponds to the international ECTS scale.

Tentative list of assessment tools

II / II	Assessment tool	Brief features	Assessment tool representation in the kit
<i>Class work</i>			
1	Survey/Quiz	A tool of control, organized as a special conversation between a teacher and students on topics related to the course under study, and designed to clarify the amount of students' knowledge in a particular section, topic, problem, etc.	Questions on the course topics /modules
2	Test	A system of standardised tasks that allows the teacher to automate the procedure for measuring the student's level of knowledge and skills	Tests bank

9.	Presentation (defence) of project/report/ Library research paper /briefs *	A tool for monitoring the students' ability to present the work results to the audience.	Themes for projects/reports/ Library research paper/ briefs
10	Pass/Fail assessment	A tool for checking the quality of students' performance of laboratory work, acquisition and mastering of the practice training and seminar educational material, successful completion of the advanced field internship and pre-graduate internship and fulfillment of all training assignments in the course of these internships in accordance with the approved programme.	Tasks examples
11	Exam	The evaluation of the student's work during the semester (year, the entire period of study, etc.); it is designed to identify the level, soundness and systematic nature of theoretical and practical knowledge gained by the student, formation of independent work skills, development of creative thinking, ability to synthesise the acquired knowledge and apply it to solve practice tasks.	Examples of tasks/questions/exam question cards
14	Multi-level tasks and assignments with varying difficulty	The tasks and assignments differ in terms of the following levels: a) reproductive level allows the teacher to evaluate and diagnose the students' knowledge of factual material (basic concepts, algorithms, facts) and the students' ability to correctly use special terms and concepts, recognize objects of study within a certain section of the discipline, b) reconstructive level allows the teacher to evaluate and diagnose the students' abilities to synthesise, analyse, generalise factual and theoretical material and formulate specific conclusions, establish cause-and-effect relationships,	Set of multi-level tasks and assignments with varying difficulty
		c) creative level allows to evaluate and diagnose students' skills to integrate knowledge of various fields, argue their own point of view.	
<i>Self- studies</i>			
1	Calculation and graphic work	A tool for checking students' skills in applying the acquired knowledge according to a predetermined methodology in task solving or fulfilling assignments for a module or discipline as a whole.	Set of tasks for calculation and graphic work

8	Homework	<p>The tasks and assignments differ in terms of the following levels:</p> <p>a) reproductive level allows the teacher to evaluate and diagnose the students' knowledge of factual material (basic concepts, algorithms, facts) and the students' ability to correctly use special terms and concepts, recognize objects of study within a certain section of the discipline,</p> <p>b) reconstructive level allows the teacher to evaluate and diagnose the students' abilities to synthesise, analyse, generalise factual and theoretical material and formulate specific conclusions, establish cause-and-effect relationships,</p> <p>c) creative level allows the teacher to evaluate and diagnose students' skills to integrate knowledge of various fields, argue their own point of view.</p>	Set of multi-level tasks and assignments with varying difficulty
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Criteria for assessing students' knowledge

	Points BRS	Traditional grades in the Russian Federation	Points for transferring grades	Grades	ECTS grades
	86 - 100	5	95 – 100	5+	A
			86 – 94	5	B
	69 - 85	4	69 – 85	4	C
	51 - 68	3	61 - 68	3+	D
			51 - 60	3	E
	0 - 50	2	31 - 50	2+	FX
			0 - 30	2	F

Explanation of the rating table:

A	“Excellent” - the theoretical content of the course is mastered completely, without gaps, the necessary practical skills for working with the mastered material are formed, all the training tasks provided for by the training program are completed, the quality of their implementation is estimated by a number of points close to the maximum.
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B	“Very good” - the theoretical content of the course is mastered completely, without gaps, the necessary practical skills for working with the mastered material are basically formed, all the training tasks provided for by the training program are completed, the quality of most of them is estimated by a number of points close to the maximum.
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C	“Good” - the theoretical content of the course has been mastered completely, without gaps, some practical skills in working with the mastered material are not sufficiently formed, all the training tasks provided for by the training program have been completed, the quality of none of them has been assessed with a minimum number of points, some types of tasks have been completed with errors.
D	“Satisfactory” - the theoretical content of the course has been partially mastered, but the gaps are not significant, the necessary practical skills for working with the mastered material are basically formed, most of the training tasks provided for by the training program have been completed, some of the completed tasks may contain errors.
E	“Mediocre” - the theoretical content of the course is partially mastered, some practical work skills are not formed, many training tasks provided for by the training program are not completed, or the quality of some of them is estimated by a number of points close to the minimum.
FX	“Conditionally unsatisfactory” - the theoretical content of the course has been partially mastered, the necessary practical skills have not been formed, most of the training tasks provided for by the training program have not been completed, or the quality of their implementation has been assessed with a number of points close to the minimum; with additional independent work on the course material, it is possible to improve the quality of the implementation of educational tasks.
F	“ Definitely unsatisfactory” - the theoretical content of the course has not been mastered, the necessary practical work skills have not been formed, all the completed training tasks contain gross errors, additional independent work on the course material will not lead to any significant improvement in the quality of the training tasks.

Modern remediation technologies / Современные технологии рекультивации

Set of tasks for calculation and graphic work, simulator training

Task (assignment) 1 calculation of the possibility of discharging wastewater from the workshop into a flowing water body for household purposes without preliminary treatment

Task (assignment) 2 Calculation of the main parameters of the municipal solid waste landfill

Task (assignment) 3 Calculation of landfill gas emissions generated during the disposal of municipal solid waste

Task (assignment) 4 the choice of technology when creating a vegetation cover on disturbed lands is

Questions to prepare for the certification test in the discipline “Nature Protection and Accumulated Environmental Damage (AED) Elimination Tools”:

- 1) What technological solutions are NOT used in the rehabilitation of NEU facilities?
- 2) What is composting?
- 3) What methods include the use of biocells (biopills)?

- 4) What does Phytorehabilitation include?
- 5) What do ex situ technologies include?
- 6) What is Controlled Natural Self-Cleansing?
- 7) What does on-site technology include?
- 8) The possibility of effective application of technological solutions for the liquidation of objects (NEU) depends on..?
- 9) What is the object of accumulated environmental damage? Definition
- 10) Do we have natural substances that pollute water bodies?
- 11) What is the main difference between a sanitary landfill and a permitted landfill?
- 12) Creating vegetation cover on disturbed lands is...?
- 13) What is Restoration of Disturbed Lands called?
- 14) Which method of processing organic waste is NOT biotechnological?
- 15) What methods relate to thermal waste processing?
- 16) The most important criterion for establishing the priority of actions to liquidate a specific AED facility.

Response Evaluation Criteria	Points		
	The answer partially meets the criterion	The answer partially meets the criterion	The answer fully meets the criterion
The student gives an answer without leading questions from the teacher	0-2	1-3	3
The student practically does not use the prepared answer manuscript	0-2	1-3	3
The answer shows the teacher's confident knowledge of the terminological and methodological apparatus of the discipline/module	0-2	1-3	3
The answer has a clear logical structure	0-2	1-3	3
The answer shows the student's understanding of the connections between the subject of the question and other sections of the discipline/module and/or other disciplines/modules of the EP	0-2	1-3	3
ИТОГО			15

DEVELOPER:

Associate Professor of the EM
Department

Kapralova D.O.

Position

Signature

Name, Surname

HEAD OF DEPARTMENT:

Director of the EM Department

Kucher D.E.

Position

Signature

Name, Surname

HEAD OF PROGRAMME:
Associate Professor of the EM
Department

Kapralova D.O.

Position Signature

Name, Surname