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**Federal State Autonomous Educational Institution for Higher Education
PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA NAMED AFTER PATRICE LUMUMBA
(RUDN University)**

Institute of Environmental Engineering

COURSE SYLLABUS

Climate Change Models

Recommended by the Didactic Council for the Education Field of:

05.04.06 "Ecology and Nature Management"

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

Climate Projects Management

1. COURSE GOAL(s)

The course is designed to help students to obtain the complex theoretical and applied knowledge in modelling historical and actual climate change processes, as well as assessment of climate risks and mitigation of climate change consequences.

2. REQUIREMENTS FOR LEARNING OUTCOMES

The process of studying the discipline is aimed at the formation of the following competencies:

Competence code	Competence descriptor	Competence formation indicators
GPC-2	Able to use special and new sections of ecology, geoecology and environmental management in solving research and applied tasks of professional activity	GPC-2.1 knows the basics of ecology, geoecology, environmental economics and closed-loop economics, as well as environmental management
		GPC-2.2 able to use environmental, economic and other special knowledge and algorithms to solve professional problems
		GPC-2.3 able to find, analyze and competently use the latest information and modern techniques in the performance of research and applied tasks
PC-4	Able to carry out an environmental analysis of projects for expansion, reconstruction, modernization of existing production facilities, taking into account the requirements of standards in the field of greenhouse gas management	PC-4.1 able to calculate the absorption/ emissions of greenhouse gases and predict their changes depending on the selected technologies
		PC-4.2 able to develop climate projects

3. COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

Discipline *Climate Change Models* refers to the **University Disciplines Module** block 1 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*
GPC-2	Able to use special and new sections of ecology, geoecology and environmental management in solving research and applied tasks of professional activity	No	Carbon Cycles / Углеродные циклы
PC-4	Able to carry out an environmental analysis of projects for expansion,	No	Carbon Cycles / Углеродные циклы

	reconstruction, modernization of existing production facilities, taking into account the requirements of standards in the field of greenhouse gas management		Climate Project Development / Разработка климатических проектов Carbon Test Areas and GHG Monitoring / Организация карбоновых полигонов
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4. COURSE WORKLOAD AND ACADEMIC ACTIVITIES

The total workload of the course 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>						
Lectures		17	17			
Lab works						
Seminars (workshops/tutorials)		17	17			
<i>Self-study</i>		83	47			
<i>Evaluation and assessment (exam; pass/fail grading)</i>		27	27			
The total course workload	hours	108	108			
	credits	3	3			

5. COURSE CONTENTS

Table 5.1. The content of the discipline (module) by type of educational work

Title of Course Modules	Content	Types of academic activities
Introduction	Climate of the Earth: history, reconstructions, theories	L, S
Assessment of the role of greenhouse gases in the climate change	Greenhouse gases, their main properties and contribution to the global warming	L, S
A human impact on climate	Homan activity and assessments of GHG emissions. The most important greenhouse gas flows. Emissions and removals	L, S
Climate risk and mitigation strategies	Climate risk and mitigation strategies: basic concepts; manifestations of risk, indicators, efficiency of mitigation strategies	L, S

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. 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
Seminars	Classroom, equipped with a set of specialized furniture; whiteboard; a set of devices includes portable multimedia projector, laptop, projection screen, stable wireless	
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. RESOURCES RECOMMENDED FOR COURSE STUDY

Main reading:

1. Krishnan R, Sanjay J, Gnanaseelan C, Mujumdar M, Kulkarni A, Chakraborty S. Assessment of climate change over the Indian region: a report of the ministry of earth sciences (MOES), government of India. Springer Nature; 2020.
2. Letcher, Trevor, ed. "Climate change: observed impacts on planet Earth." (2021). <https://books.google.com/books?hl=en&lr=&id=psr2DwAAQBAJ&oi=fnd&pg=PP1&dq=climate+change+models+book&ots=yCwibhOE57&sig=2QHegfwy2GyHxkOWmpcll420UUU>

Additional reading:

1. Neelin, J. David. Climate change and climate modeling. Cambridge University Press, 2010.
2. Bonan, Gordon. Climate change and terrestrial ecosystem modeling. Cambridge University Press, 2019. URL: https://books.google.ru/books?hl=en&lr=&id=BYaEDwAAQBAJ&oi=fnd&pg=PR13&dq=climate+change+models+book&ots=gqnEFggQpr&sig=TP5ls7cjtY1GfgwDDd-kj756dh4&redir_esc=y#v=onepage&q=climate%20change%20models%20book&f=false
3. Ahmed M. Introduction to Modern Climate Change. Andrew E. Dessler: Cambridge University Press, 2011, 252 pp, ISBN-10: 0521173159. URL: https://www.sciencedirect.com/science/article/pii/S0048969720329144?casa_token=07_vawh1CfwAAAAA:ml9v92wL75dqTrb7JzOTyau2qlZqfa_5657DBwWTrgyQ7BkI6

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/](https://www.yandex.ru/)
- Google search engine <https://www.google.ru/>
- abstract database SCOPUS [http:// www .elsevierscience.ru/ products / scopus /](http://www.elsevierscience.ru/products/scopus/)

8. ASSESSMENT TOOLKIT AND GRADING SYSTEM FOR EVALUATION OF STUDENTS' COMPETENCES LEVEL UPON COURSE COMPLETION

The assessment toolkit and the grading system to evaluate the level of competences (competences in part) formation as results of mastering the discipline are specified in the Appendix to the syllabus.

DEVELOPER:

Professor of the ES&PQM
Department

Position

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Name, Surname

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Director of ES&PQM Department

Position

Savenkova E.V.

Name, Surname

HEAD OF PROGRAMME:

Director of ES&PQM Department

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Savenkova E.V.

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ASSESSMENT TOOLKIT

Climate Change Models

Recommended by the Didactic Council for the Education Field of:
05.04.06 "Ecology and nature management"

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

Climate Project Management

Passport to Assessment Toolkit for Course Climate Change Models

Education Field / Speciality 05.04.06 "Ecology and nature management"/ «Climate Projects Management»

Course: Climate Change Models

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 course
			Class work					Self-studies				Exam/Pass-fail assessment		
			Quiz	Test	Work with lecture materials	Work at the seminars	Lab work	Homework	Research essay/ Library research paper/ Presentation	Calculation and graphic work	Group work project			
GPC-2 PC-4	Introduction	Climate of the Earth: history, reconstructions, theories	4		2	3							9	9
GPC-2 PC-4	Assessment of the role of greenhouse gases in the climate change	Greenhouse gases, their main properties and contribution to the global warming	4		2	3							9	9
GPC-2 PC-4	A human impact on climate	Homan activity and assessments of GHG emissions. The most	4		2	3							9	9

		important greenhouse gas flows. Emissions and removals												
GPC-2 PC-4	Climate risk and mitigation strategies	Climate risk and mitigation strategies: basic concepts; manifestations of risk, indicators, efficiency of mitigation strategies	4		2	3							9	9
		TOTAL	16		8	12			20		30	14	36	100

Course Climate Change Models

QUESTION CARD No 1

QUESTION 1. History of climate on the Earth: reconstructions.

QUESTION 2. Modelling the anthropogenic contribution to the climate change.

3 *

Developer _____ (Redina Margarita)
signature

Head of Educational Department _____ (Savenkova Elena)
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)

EXAM QUESTIONS

1. Historical reconstructions of the climate on the Earth.
2. Main natural factors of the climate change.
3. Greenhouse effect and it's first models. J. Fourier and J. Tyndall works.
4. Assessment of the contribution of GHG to the global warming.
5. Methods of paleoclimatologic studies.
6. Direct climate observations and reconstructions.
7. GHG emissions: mitigation scenarios based on the climate change models.
8. Modelling GHG fluxes: CO₂, CH₄, N₂O.
9. UN Framework Convention on Climate Change (UNFCCC) secretariat and global climate change models.
10. The Intergovernmental Panel on Climate Change and global models.
11. Quantitative models of GHG fluxes: solid waste disposal on land case study. Composition of landfill gas in different phases of the degradation process.
12. Global anthropogenic CO₂ budget.
13. GHG monitoring as a base for the modelling.
14. Climate risk and climate factors. A climate-conditioned risk.
15. Keeling model and it's critical analyses.

Tentative list of assessment tools

No	Assessment tool	Brief features	Assessment tool representation in the kit
<i>Class work</i>			
1	Survey/Quiz	A tool of control, organised 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
3	Control work	A tool of control organised as a classroom lesson, at which students need to independently demonstrate the acquisition and mastering of the educational material of the course topic, section, or sections.	Questions on the course topics /modules
4	Round table, discussion, polemic, dispute, debate, (class work)	Evaluation tools that allow the teacher to engage students in the process of discussing controversial issues, problems and assess their ability to argue their own point of view.	List of themes for round tables, discussions, polemics, disputes, debates.
5	Business game and/or role play	Joint activities of a student group under the teacher's control to solve educational and professionally oriented tasks through the simulation of a real-world problem; this activity allows the teacher to assess the students' ability to analyse and solve typical professional challenges.	Topic (problem), concept, roles and expected results for each game
6.	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
7	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
8	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	Examples of tasks/questions/exam question cards

		thinking, ability to synthesise the acquired knowledge and apply it to solve practice tasks.	
9	Case	A problem-solving task in which the student is asked to comprehend the real work-related (occupational) situation necessary to solve the problem.	Assignments to solve the case
10	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, c) creative level allows to evaluate and diagnose students' skills to integrate knowledge of various fields, argue their own point of view.	Set of multi-level tasks and assignments with varying difficulty
Self- studies			
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
2	Course work/project	A type of independent written work aimed at the creative development of general professional and specialised professional disciplines (modules) and the development of relevant professional competences	Course assignment themes
3	Project	The final "product" that results from planning and performance of educational and research tasks set; it allows the teacher to assess the students' ability to independently shape their knowledge in the course of solving practice tasks and problems, navigate in the information environment and the students' level of analytical, research skills, skills of practical and creative thinking; it can be implemented individually or by a group of students.	Themes for team-based or individual projects
4	Reports, briefs	The product of the student's independent work, which is a public performance on the presentation of the results of solving a specific educational, practical, research or scientific topic.	Themes for reports, briefs
5	Standard calculations	A tool to test skills in applying the acquired knowledge, according to a predetermined methodology, solving tasks or fulfilling	Set of tasks for standard calculations

		assignments for a module or discipline as a whole.	
6	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

Department of Environmental Safety and Product Quality Management

Set of assignments for control work

for the course **Climate Change Models**

Card 1.

- 1) What are GHG natural sources and GHG sinks?
- 2) What are climate risks and what are their manifestations?

Assessment criteria:

(in compliance with the legal regulations in force)

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day, month, year

Department of Environmental Safety and Product Quality Management

Set of assignments for the presentation

for the course **Climate Change Models**

The topics listed are preliminary; necessary to agree a with a teacher!

- 1) *J. Fourier works on a greenhouse effect.*
- 2) *J. Tyndall works on infrared radiation is absorbed by water vapor and carbon dioxide.*
- 3) *S. Arrhenius works on the influence of anthropogenic activity on changes in the greenhouse effect.*
- 4) *Modern global models of climate change.*
- 5) *Modern assessments of climate risks.*

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Department of Environmental Safety and Product Quality Management

Business game and/or role play

for the course **Climate Change Models**

The purpose of the game is to develop a critical analyses skills in discussions of various models of climate change.

Algorithm

1. The group is divided in two subgroups; the 1st one prepares presentation on the modeling and the 2nd prepares questions on the same topic.
2. In the seminar the 1st group presents a material on the certain model: a history of a modelling, necessary data, approaches to their processing, main points of the model and it's result.
3. The 2nd group presents arguments against the conclusions of the model.
4. After the discussion, both the groups present joint conclusions about the model: it's strong and weak sides, factors which could be included to the model.

Task defense form – Power Point presentation of the report.

Assessment criteria:

(in compliance with the legal regulations in force)

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