



UNIVERSITY OF THE ARCTIC

Circumpolar Studies Program



ЯКУТСКИЙ ГОСУДАРСТВЕННЫЙ
УНИВЕРСИТЕТ
ИМ. М.К. АММОСОВА

Advanced Emphasis Title: Geographical-Nature Conditions of the Territory of Cryolitozone

Institution: [Sakha State University](#)

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Start Date: Courses in this AE are offered as per availability in the Fall and Spring semesters

Delivery Method: Only onsite, *taught in Russian and available only to Russian students*

Application deadline:

Credits: 30 ECTS (15 North American credits at most institutions)

Requirements: This is a sciences based undergraduate programme.

Advanced Emphasis Description:

The course will provide students with knowledge on geography, climate, and natural zones and resources of the permafrost areas.

Courses:

1. CLIMATE OF COLD REGIONS (1,7 ECTS)

Course description

The course deals with learning of processes and structure of the climate as a geographic membrane of the Earth. The course will introduce students to method of description of northern territories climate, climatic features of different natural conditions.

Course structure

Lectures (2 hours a week). Individual test work in the form of term paper.

Total hours: 60, including lectures- 36, assignments- 20, tests- 4.

Prerequisites: three years of undergraduate study

Semester: Fall (4 months or 18 weeks)



Evaluation – oral test.

Learning outcomes

Upon completion of the course a student will

- *learn about* consistence, structure and dynamic relationship between the Earth and the Sun that form the climate;
- *be aware of* peculiarities of cold regions, main forms of radiation, circular, terrestrial and underground processes of northern territories and distinguish climates of different regions;

Course objectives:

The course will give students knowledge on principles of climate formation in cold regions and value of atmospheric phenomena and processes in professional activity. Besides, it provides students with knowledge on types of climate including cold regions and principles and methods of cold climate description.

Course content

Introduction, 2 hours.

Course description, objectives. Main terms, concepts, definitions (“climate”, “eternal frost”, “cold region”, “the North”).

Climate of the Earth in the world system, 4 hours.

Relationship between climate and surface glaciation and permafrost. Genetic view: climate-glaciation. Space factors of the climate and surface and underground Earth glaciation (solar climate). Astronomic factors and glaciation in different climatic zones. Climate factors and geographic features of glaciers and permafrost.

General characteristics of the Earth climate, 6 hours.

Radiation balance. Water balance. Temperature of the air, earth surface, grounds. Climatic zoning of the Earth.

Macroclimate of cold regions, 20 hours.

Macroclimate of cold regions and landscape situation of modern glaciation. Cold regions: Russia, Western Europe, Foreign Asia, Africa, North America, South America, South oceanic islands, Macroclimate of the Antarctic Continent. Climate changes, 4 hours. Climates of past, present and future; glaciation and permafrost. Climate changes and its natural and economical consequences.

Literature:

1. Alisov B.P. Climate of the USSR.-Textbook.M.: High school, 1969.- 104 p.
2. Gavrilova M.K. Climates of the Earth’s cold regions. Yakutsk: izd-vo SORAN, 1998, 2003.-208p
3. Myachkova N.A. Climate of the USSR. – Schoolbook.- M.: izd-vo MGU, 1983.- 192p.

Anthology :

1. Alisov B.P., Berlin I.A., Mikhel V.V. The course of climate science. Part III. Climates of the Earth.- Schoolbook.- L.: Gidrometeoizdat, 1954. – 320 p.
2. Alisov B.P. Climatic regions of foreign countries.- M.: Geografiz, 1950.- 352 p.
3. Gavrilova M.K. The climate of the Central Yakutia.-Yakutsk: Kn. Izd-vo, 1973.- 120 p.
4. Gavrilova M.K. The climate and perennial freezing of the earth material.- Novosibirsk: Nauka, 1978. – 214 p.
5. Gavrilova M.K. Radiating climate of the Arctic.-L.: Gidrometeoizdat, 1963.-226 p.



6. Gavrilova M.K. Modern climate and eternal froze on continents.- Novosibirsk : Nauka, 1981, -113 p.+ 6 cards-inset.
7. Zanina A.A. Far Eastern regions, Kamchatka and Sakhalin. – L.: Gidrometeoizdat, 1958.-168 p.
8. Climate of the Yakutsk. –L.: Gidrometeoizdat, 1982.- 247 p.
9. Climate of the Yakut ASSR (atlas).L.:Gidrometeoizdat, 1986.-32 p.
10. Orlova V.V. Western Siberia. –L.: Gidrometeoizdat, 1962.- 369 p.- (Climate of the USSR. Publ.4).
11. Scherbakova E. Y. Eastern Siberia.-L., Gidrometeoizdat, 1961.- 300 p. (Climate of the USSR. Publ.5).

2. RIVERS OF THE PERMAFROST ZONE (1,7 ECTS)

Course description:

The course gives students knowledge on formation of the river run-off under condition of permafrost and characteristics of river regimes. The “Rivers of Permafrost regions” course is one of the core courses in higher education diploma obtaining. It provides students with fundamental knowledge in the sphere of theory and practice and facilitates research training.

Course structure

The course ” is offered for the 3-rd-year students in the Spring term and dures for 4 months (18 weeks), Lessons are conducted once a week (2 hours).

Total number of hours- 60, including lectures- 36, student individual work- 20, test works- 4.

Form of evaluation- test work.

Students’ activity is composed from following types of work:

1. Contact hours- lectures, passing total examination.
2. Individual work- assignments and thesis.

Course objectives

The course Rivers of Permafrost regions course will enable a student to apply theoretical knowledge in practice, acquire experience and working skills. The course will provide a student with understanding of formation of hydrologic regime of rivers of cryolitozone, its features and modern methods of processing and analyzing of information on hydrology of the rivers. Besides, a student will learn main principles, methods and rules of description of the hydrological regime of permafrost zone rivers.

Course content

Introduction to the course (6 hours): course objectives, tasks; main terms, notions, definitions.

Brief information on the history of development of permafrost rivers hydrology.

Natural conditions of the permafrost zone: climate, relief, geology, soils, plant cover.

Physical-geographical factors of formation of hydrological regime of rivers of the permafrost zone (96 hours).

Peculiarities of hydrological regime of rivers of the permafrost zone (26 hours).

Learning outcomes

Upon completion of the course a student will:

- **Have an idea on** distribution of hydrological characteristics on the permafrost territories; on processes and developments observed on rivers of the permafrost zone; on main spheres of application of the obtained knowledge;



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- **Be aware of** the subject, goals and tasks of the course; concepts, definitions, terms, irregularities of permafrost zone rivers' hydrology; methods of hydrologic exploration, investigations and calculations in conditions of permafrost; practical importance of inter-relations climate- rivers- permafrost research in the solution of environmental problems;
- **Be able to** generalize and analyze initial hydrometeorological information; define basic hydrologic characteristics and make hydrologic calculations using methods and techniques of tasks solution; draw conclusions, implications and make accurate calculations;

Literature:

1. Arzhakova S.K. Winter stream flow of permafrost zone rivers.- St.P: RGGMU, 2001.- 211p.
2. Budiko M.I. Climate in the past and in the future.- L.: Gydrometeoizdat, 1980.- 352p.
3. Gavrilova M.K. Climates of the Earth's cold regions: Schoolbook.- Yakutsk: Izd-vo SO RAN, 1998.- 206p.
4. Gavrilova M.K. Modern climate and eternal froze on continents.- Novosibirsk: Nauka, 1981.- 111p.
5. Resources of open water in the USSR. T.16, 17, 19.
6. Sokolov A.A., Tchebotarev A.I. Sketch- book of hydrology's development in the USSR.- L.: Gidrometeoizdat, 1970.- 309p.
7. Sokolov B.L. Hydrology of permafrost zone rivers- new section of earth's hydrology.-// Problems of modern hydrology.- L.: Gydrometeoizdat, 1989, p.195- 205.

Anthology:

1. Gavrilova M.K. and others. Influence of climates on cryosolic landscapes of Central Yakutia.- Yakutsk: In-t merzlot. SO RAN- associirovanny tchlen izd-va SO RAN, 1996.- 152p.
2. Kobak K.I., Kondrasheva N.Yu. Global warming and natural zones. – and hydrology, 1992, №8, p.91-98.

3. LAKES OF THE PERMAFROST ZONE (1,7 ECTS)

Introduction

Study of the “Lakes of the permafrost zone” course gives students an opportunity to apply the obtained knowledge in practice and get a working experience under condition of permafrost rocks.

Learning outcomes

A student studying within the network of the University of the Arctic will

- **Get information** on the character of lymnogenesis and features of territorial dislocation of various lakes. Besides it is important for a student to get knowledge on peculiarities of limnic processes in frozen landscapes under condition of permafrost, on natural resources of lakes of northern territories and main trends of their management in cold climate;
- **Study** the course objectives, tasks and value. A student will be acquainted to course notions, terms, research methods for lakes of the cold (permafrost) regions, features of permafrost lake studies and lake resource studies, environmental protection issues.
- **Get skills** in summarizing and analyzing the lymnological information, determine main limnic characteristics, conduct the required calculations using standard methods and make conclusions on the subject.



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- **Obtain knowledge** on limnological survey and research, measurements and estimation.

Course priority tasks:

While studying the “Lakes of the Permafrost zone” course students will:

- Understand main principles of formation of hydrological and hydrochemical regulation of lakes under condition of cryogenic landscapes.
- Be introduced to formation character of hydrological process of cold regions lakes.
- be aware of features of lake sediments formation and sedimental lake processes in the arctic and Sub-Arctic territories.
- be acquainted with main methods and rules of limnic survey and limnological research of permafrost lakes.

Course description:

Required content of the academic program within the University of the Arctic”: study of diversity of limnological (hydrological, hydrochemical, hydrobiological sedimentary) regulations of lakes located in the permafrost landscapes. Besides it includes study of qualitative and quantitative characteristics of natural resources of the lakes. The “Lakes of the permafrost zone” course is one of the core courses in higher education diploma obtaining. It provides students with fundamental knowledge in the sphere of theory and practice and facilitates research training. The “Lakes of the permafrost zone” course is a major course due to typological variety and qualitative diversity of lakes in the cryogenic landscapes.

Course structure

The course is offered for the 3rd-year students in the **spring semester**. Course terms: 4 months (18 weeks). Classes are conducted 1 a week (2 hours).

Total hours – 60 including lectures -36, assignments -20, and test work – 4.

Evaluation form- test work.

Student activity includes:

Contact hours – lectures, test works

Individual work – assignments, thesis work

Accomplishment of test and individual works on the course is based on study of the recommended literature.

Course content

Course introduction, 2 hours

The introduction includes general concept of lakes as an aquatorial type, Lakes studies as a branch of hydrology.

Lakes studies: brief history, 2 hours

Lakes studies of the permafrost zone

Kettle lake , 4 hours.

Morphologic characteristic of permafrost lakes. Genetic classification of kettle lakes. Morphometry of lakes and kettle lakes. Morphogenesis of lakes of the permafrost zone. Morphogenetic classification of lakes of the permafrost zone.

Water nutrition and level mode, 4 hours

Water balance. Features of water balance of the permafrost zone lakes. Thermals and ice mode of lakes. Thermal balance. Thermal balance character of lakes in the permafrost zone.

Lake water flow, 2 hours



Stream waves, ebbs and onset, seiches, stirring.

Hydrochemistry of lake water, 2 hours

Character of lake hydrochemistry in the permafrost zone. Mineral lakes.

Shores, 2 hours

Shore formation. Shore formation in the permafrost zone. Bottom silts. Formation and diagenesis of lake deposits. Putrid mud (sapropels). Peloid. Features of lake deposits in the permafrost zone.

Lake life, 4 hours

Plankton, neuston, nekton, benthos of lakes, biotopes, hydrobiology peculiarities of lakes in the permafrost zone.

Lake fish, 4 hours

Fish capacity. Permafrost lakes: fisheries value.

Paleolimnological problems of the permafrost zone, 2 hours.

Lake eco-systems, 2 hours.

Ecological monitoring of lakes.

Problems in complex economic use and protection of lakes of the permafrost zone, 2 hours.

Lake eco-systems.

Main principles:

1. Succession (historicity)
2. Complexity
3. Practical way

Recommended literature

1. Bogoslovsky B.B. Lake studies. – M.: Izdatelstvo MGU. 1960-p. 351
2. Lopotko M.Z., Evdokimova G.A. Sapropels and products based on them/under edition of N.V. Kislova.-Mn.: Nauka i Tekhnika, 1986.-p.191
3. Korde N.V. Methods of biological study of lake bottom silts (field work and biological analyses)//Life of clean waters of the USSR.-M.:Nauka, 1956.-T. 4.-4.1.-p.383-413.
4. Kirillov F.N. Fish of Yakuta.-M.:Nauka, 1972.-p. 360
5. Kleymenova G.I., Sevastyanov D.V. Complex paleogeographic analyses for reconstruction of lakes and landscapes evolution in the north-east Ladoga lake in Holocene period//Vestnik of St.Petersburgs.-SPb., 1995.-ser.7.-edition 3 (#21).-p.68-79.
6. Ignatiev V.A., Zhirkov I.I. Lake classification of Central Yakutia: proceedings of the regional meeting on studies of Siberia lakes//Water basins of Siberia and perspectives of their fishery management.-Tomsk, 1973.-pp. 30-31.
7. Yakushko O.F. Lake studies: geography of lakes of Belorussia.-Minsk:Vysshaya shkola, 1981.-p.223
8. Henderson-Sellers B., Marklind X.R. Dying lakes. Reasons and control of the industrial eutrophication//translation from English.-L.:Gidrometeoizdat. 1990, p.280.

Anthology

1. Adamenko V.N. Climate and lakes.-L.:Gidrometeoizdat, 1985.-p.263
2. Kuznetsov S.I. Micro flora of lakes and its geochemical activity.-L.:Nauka. 1970.-p.440



4. PERMAFROST STUDIES (1,7 ECTS)

Course structure

The course is offered for the 2-nd-year students during the Spring semester and lasts for 4 months (18 weeks). The classes are conducted 1 a week (2 hours per week). Total amount of hours is 60 including 36 lectures, individual work – 20 hours, test work – 4 hours.

Evaluation – test work

Student activity:

Contact hours: lectures, final test

Individual work and test work in the form of thesis (Thesis on “Geocryological notions and terms”.) Individual work includes complex geocryological features of permafrost regions)

Learning outcomes

Upon completion of the course a student will:

- learn to describe geo-cryological conditions, permafrost (frozen-geological) processes and phenomena;
- to reveal factors of development and distribution of permafrost soils and their reflection in the regional variety of permafrost;
- make an assessment of regional geo-cryologic problems

Course content

Introduction to the course – 6 hours (objectives, terms, notions and definitions; permafrost as a branch of the planet cryology; history of permafrost study; frozen rocks – natural historical geological formations; structure, tasks and permafrost trends (dynamic geo-cryology; litho-genetic cryology, regional and historical geo-cryology, engineering geo-cryology)

Composition, structure, cryogenic processes and features of frozen rocks – 10 hours (Thermal-physical properties of rocks; composition of frozen dispersed rocks; cryogenic composition of frozen rocks, types of cryogenic textures and their classification; cryogenic geological processes and phenomena, their classification)

Principles of formation and development of strata of frozen rocks and seasonal freezing and melting – 10 hours

Zonal and regional peculiarities of cryolite zone – 10 hours

Literature

1. E.D. Ershov General geo-cryology.
2. Permafrost (brief course)/under edition of E.D. Ershov
3. Methods of permafrost survey
4. General permafrost studies
5. Introduction to geo-cryology. vol.3. regional and historical geocryology of the World/edited by E.D. Ershov-M.:Publishing house of the Moscow State University. 1998-575pp.
6. Woshborn A.L. World of frost. geo-cryological research – M.: Progress, 1988

5. MARSHES OF THE ARCTIC LANDSCAPES (1,7 ECTS)

Course description

Marshes and marshy lands are the products of the biosphere evolution. Their main bio-spherical functions are: accumulative, biological, hydrological, geo-chemical, climatic and gas-regulating. The marshes are in a special place between small biological and big geological substance



cycle. Marshy eco-systems play a key-role in the global processes of carbon connection and oxygen regeneration, water balance support, preserving of biological diversity on vast territories. Studying marshes one can easily see that they are an important part in the chain of nature components connected with each other. Marshes are regulators of water balance. As an element of ecological system marshes are characterized by specific flora and fauna. Besides, marshes are a source of valuable sorts of raw materials: black dirt, medical dirt etc.

Course structure

Theme 1. Bogginess of the arctic territories (lectures – 4, seminars – 2, individual work – 2)

Theme 2. Formation of Marshes (lectures-10, seminars – 6, individual work -2)

Theme 3. Factors of Bogginess in the Arctic areas – (lectures-18, seminars-6, individual work-8)

Theme 4. Flora of marshy areas (lectures-10, seminars-4, individual work-6)

Theme 5. General information on bog muck, its formation condition and accumulation (lectures-20, seminars-10, individual work-6)

Theme 6. Age of peat deposits (lectures-10, seminars-4, individual work-6)

Theme 7. Economical development of marshes and marshy areas (lectures-6, seminars-4, individual work-4)

6. GEO-CRYO-ECOLOGY OF THE ARCTIC TERRITORIES (1,8 ECTS-3,4 ECTS)

Course description

The course ‘Geocryology of the Arctic’ is an original course as the territory of the Arctic differs from other Earth areas with high activity of frozen processes and phenomena that create a specific character of ecological problems of the area. Moreover, ecologically unfavorable processes and phenomena can suddenly activate due to industrial impact. Geo-cryology is a branch of geography and general permafrost studies. Development of these two sciences helped us to learn about the processes of formation and functioning of permafrost geo-systems.

Learning outcomes

Upon completion of the course a student will **learn methods** of analyses and synthesis of the objective geo-cryological situation, development and realization of certain measures and activities necessary for solving ecological tasks and providing safety life conditions.

Course structure

Theme 1: Cryo-geosystems, their function and dynamics (lectures – 4, seminars-0, individual work – 2)

Theme 2: Cryogenic soil formation (lectures – 8, seminars-6, individual work-4)

Theme 3: Secular variation of main characteristics of the active layer (lectures-10, seminars-6, individual work-4)

Theme 4: Underground ice and dynamics of cryo-geosystems (Lectures-6, seminars-4, individual work-4)

Theme 5: Littoral zone of the Arctic seas (lectures-6, seminars-2, individual work-4)

Theme 6: Stability of cryogeosystems (lectures-20, seminars-8, individual work-4)

Theme 7: Role of flora in preservation of geosystem stability (lectures-6, seminars-2, individual work-2)

Total course hours – 70-130