APPROVED
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Protocol № 11 from 23.05.2025 y.

Entrance Examination Program for Applicants to Doctoral Studies in the Educational Program Group D085 – "Hydrology"

I. General Provisions

1. This program is developed in accordance with the Order of the Minister of Education and Science of the Republic of Kazakhstan dated October 31, 2018, No. 600 "On the Approval of Standard Rules for Admission to Education in Organizations Implementing Educational Programs of Higher and Postgraduate Education" (hereinafter referred to as the Standard Rules).

2.The doctoral entrance examination consists of an interview, writing an essay, and a subject-specific examination.

Component	Points
1. Interview	30
2. Essay	20
3. Examination in the profile of the educational program group	50
Total / Passing score	100 / 75

3. The duration of the entrance examination is 3 hours and 10 minutes, during which the applicant writes an essay and answers questions from an electronic examination ticket. The interview is conducted at the university prior to the entrance exam.

II. Procedure for Conducting the Entrance Examination

1. **Applicants to the doctoral program in the educational program group D085 – "Hydrology" must write a problem/thematic essay.**

The essay must be at least 250 words in length.

Purpose of the essay – to determine the level of analytical and creative abilities, expressed in the ability to construct one's own argumentation based on theoretical knowledge, social and personal experience.

Types of essays:

- Motivational essay revealing the driving motives for research activity;

- Scientific-analytical essay justifying the relevance and methodology of the planned research;
- Problematic/thematic essay reflecting various aspects of scientific knowledge in the subject area.

2. **The electronic examination ticket consists of 3 questions.**

Topics for exam preparation according to the profile of the educational program group:

Discipline: Hydrometry

Topic 1: Organization of work at hydrological posts

Subtopics:

1. Classification of hydrological posts by purpose, duration of work, type of equipment, and their main types. Simple posts (rake, pile, combined);
2. Purpose and objectives of water discharge determination. Methods of discharge measurement. Selection of river section. Layout and equipment of hydrometric cross-sections. Discharge determination using the "velocity-area" method;
3. Field chemical laboratory, necessary equipment. Determination of water chemical composition in the field and in the laboratory.

Topic 2: Modern hydrometric instruments and water cadastre

Subtopics:

1. Modern automatic water level recording devices (AWLR), characteristics and principles of various hydrometric devices;
2. Types of remote installations and their principles of operation (GR-70, GR-64);
3. Possible schemes for integrated automation of hydrometeorological services. Installation of automated systems ARRGP (GR-103), ARMS, etc.;
4. State accounting of water quantity and its use. Main sections of the state water accounting and its information support. State Water Cadastre (SWC) and its sections. SWC publication and data storage.

Discipline: Fundamentals of Hydrology

Topic 1: Hydrosphere, hydrological regime, and hydrological processes

Subtopics:

1. Water resources of world continents, CIS countries, Kazakhstan;
2. Main zonal and azonal factors influencing the land water regime;
3. Hydrological characteristics of different regions of Kazakhstan.

Topic 2: River Hydrology

Subtopics:

1. Hydrological regime of rivers, phases of water regimes;
2. Classification of rivers based on water regime, classifications by A.I. Voeikov, M.I. Lvovich, B.D. Zaykov, P.S. Kuzin;
3. River and river system. Hydrographic network. Morphology and morphometry of rivers and river basins;
4. River runoff. Characteristics of annual runoff. Typical hydrograph;
5. Impact of economic activities on river regimes. Anthropogenic changes in river runoff.

Topic 3: Hydrology of lakes, reservoirs, glaciers, and wetlands

Subtopics:

1. Origin and types, morphology and morphometry of lakes;
2. Thermal regime and classification of lakes. Hydrological features of reservoirs;
3. Main characteristics of reservoirs. Silting of reservoirs. Impact of reservoirs on river runoff and the environment;

4. Glaciers – distribution and regime. Hydrological features of glaciers;
5. Wetlands – origin, development. Types of wetlands, hydrological regime, distribution.

Discipline: Hydrological Calculations

Topic 1: Study and application of methods for calculating annual river runoff characteristics

Subtopics:

1. Factors affecting river runoff;
2. Methods for analyzing hydrological information;
3. Patterns of annual runoff fluctuations;
4. Calculation of runoff norm with sufficient and insufficient observation data;
5. Variability of annual runoff and methods for determining values with specified exceedance probabilities;
6. Intra-annual runoff distribution;
7. Minimum runoff.

Topic 2: Calculation of maximum river runoff

Subtopics:

1. Importance of maximum water discharge for construction and water management;
2. Calculation of maximum runoff with observational data;
3. Calculation of maximum runoff with short or absent data series;
4. Maximum runoff during floods and freshets;
5. Construction of runoff hydrographs for floods and freshets;
6. Determination of design water levels of rivers and lakes;
7. Calculation of sediment runoff.

Discipline: Modern Methods of Statistical Processing of Hydrological Information

Topic 1: Distribution curves and their characteristics. Statistical hypothesis testing

Subtopics:

1. Random variables and their distribution laws;
2. Normal distribution law, Pearson Type III curve. Probability distribution curve by S.N. Kritsky and M.F. Menkel;
3. Parameter estimation by method of moments, maximum likelihood, and graphical-analytical method;
4. Statistical hypothesis testing in hydrological studies. Student’s t-test and Fisher’s test;
5. Non-parametric hypothesis testing methods: Wilcoxon, Mann-Whitney, Dixon, Smirnov-Grubbs tests.

Topic 2: Statistical relationships in hydrology and statistical modeling of hydrological series

Subtopics:

1. Linear regression and correlation;
2. Multiple linear regression and correlation;
3. Studies of variability in time series of hydrological data;
4. Multivariate statistical analysis. Study of temporal patterns of hydrological series;
5. Statistical modeling of annual runoff series and runoff hydrographs.

Discipline: Hydrological Forecasts

Topic 1: Short-term hydrological forecasts

Subtopics:

1. Evaluation of forecasting method quality and justification. Allowable forecast error and its estimation. Criteria for applicability and quality of forecast methods. Special cases of quality evaluation;
2. Short-term water level forecasts using the method of corresponding levels in non-inflow sections;
3. Short-term forecasts of rain floods. Methods for forecasting rainfall runoff hydrograph;
4. Forecasting ice formation periods on rivers, lakes, and reservoirs. Method by L.G. Shulyakovsky;
5. Short-term forecasts of ice breakup on rivers, lakes, and reservoirs.

Topic 2: Long-term hydrological forecasts

Subtopics:

1. Basics of long-term spring flood forecasting methods. Water balance equation during flood periods. Determining total water input to basin surface;
2. Determining remaining snow reserves in the basin using initial snow storage and air temperature during melting period;
3. Long-term forecasts of peak discharges (levels) of water. Forecasting the hydrograph of spring flood runoff;
4. Long-term forecasts of summer, autumn, and winter runoff. Methods for forecasting low flow in steppe, forest-steppe, and forest zones;
5. Ice phenomenon forecasts using synoptic-statistical methods. Forecasting ice formation, ice breakup, freezing, and ice destruction on lakes and reservoirs.

Discipline: Integrated Water Resources Management (IWRM)

Topic 1: Water resources and sustainable development

Subtopics:

1. Water resources and sustainable development. Importance of water for environment and humans. Global water crisis;
2. Need for transition to IWRM in Kazakhstan. Water resources management policy and legislation in Kazakhstan. Key provisions of the Water Code of the Republic of Kazakhstan.

Topic 2: Information management in the field of water use and protection

Subtopics:

1. Water resources monitoring. Goals and objectives of monitoring water bodies. Principles of forming a water monitoring system. Stakeholders of the monitoring system;
2. Issues of optimizing water resources monitoring within water management basins of Kazakhstan;
3. International cooperation in the field of IWRM and improvement of transboundary water management;
4. International agreements on IWRM for transboundary watercourses;
5. International practices of cooperation in transboundary river basins in the field of IWRM.

Discipline: Hydrology of Urbanized Areas

Topic 1: Assessment of changes in river runoff under anthropogenic impact
Subtopics:

1. Current state of studies on the impact of human activity on water resources and hydrological regime of urbanized areas;
2. Methods for assessing the impact of different types of economic activity on runoff;
3. Water management and environmental problems of large river basins. Current issues of water resources regulation, drinking water supply, and rational use;
4. Redistribution of runoff due to urbanization. Surface runoff treatment facilities;
5. Protection of urban and residential areas from floods and water level rise.

Discipline: Reclamation Hydrology

Topic 1: Hydrological and climatic justification for irrigation reclamation
Subtopics:

1. Impact of reclamation on soil, plants, and microclimate;
2. Irrigation systems;
3. Theoretical foundations of hydrometeorological justification for reclamation.

Topic 2: Hydrometeorological calculations for irrigation reclamation
Subtopics:

1. Main elements of the water balance of irrigated lands;
2. Basics of hydrological and climatic assessment of natural moisture supply;
3. Return runoff from irrigation systems;
4. Irrigation regime and its calculation during planning of irrigation activities.

Discipline: Mudflow Problems and Mudflow Protection

Topic 1: Problems of forecasting mudflow phenomena
Subtopics:

1. The problem of forecasting mudflows, types of forecasts, authors, and proposed forecasting criteria;
2. Forecasting rain-generated mudflows and determining their forecast indicators;
3. Role of GIS technologies in mudflow forecasting;
4. Forecasting glacial mudflows and determining their forecast indicators.

Topic 2: Problems of managing mudflow risks
Subtopics:

1. Evaluation of mudflow protection measures implemented in Kazakhstan, protective measures, mudflow protection structures, Kazakhstani and international experience;
2. Measures aimed at protection from rain-induced mudflows;
3. Justification of measures taken during inter-mudflow periods;
4. Prevention of glacial mudflows;
5. Justification of measures taken during mudflow events;
6. Justification of measures taken after a mudflow event.

Discipline: Computer Technologies in Hydrology

Topic 1: Possibilities of applying computer technologies for modeling and forecasting hydrological processes
Subtopics:

1. Hydrological processes and patterns of their formation;
2. Role of hydrological models in forecasting hydrological processes;
3. Analysis of promising approaches to hydrological process forecasting;
4. Use of remote sensing data in studying hydrological phenomena and processes;
5. Organizing monitoring using remote sensing data during hazardous hydrological events;
6. Evaluation of integration between remote sensing and GIS technologies.

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