

# ICE MECHANICS

ANNUAL INTERNATIONAL WINTER COURSE



## ICE MECHANICS» WINTER COURSE

«ICE MECHANICS» is an annual international Winter Course. It was established in 2015 at School of Engineering (FEFU) as a part of activities accomplished by the International Scientific and Educational Center «Arctic» (ISEC «ARCTIC»).

The Far East of Russia is the largest region for the program of Arctic development in the coming decades. The purpose of the course is as follows:

- to obtain new knowledge on marine ice engineering with the purpose of the offshore exploring of the Arctic and the Far East;
- to improve the representation of sea ice properties in the engineering tasks for the Arctic and the Sea of Okhotsk shelf and to involve students into the research activities in this area;

- to develop informational platforms for communications between domestic and foreign professionals;
- staff training.

The students may investigate, how the ice strength and its other properties, and ice inhomogeneity are defined using the experimental equipment on-site and in the Laboratory facilities. In particular, the students make focus on the ice abrasion of concrete samples dependences on the ice properties considering the influence of normal stress, sliding rate and ice temperature. The research topics cover the operations of ships in the Arctic and sub-Arctic seas and ice-structure interaction.

### THE COURSE DEMANDS

1. To develop understanding of ice as a natural material, e.g. understanding of ice properties and features and knowledge of the ways and techniques for the laboratory or full-scale ice measurements and/or observations;
2. To expand the knowledge about the influences of ice on ships, coastal and offshore structures.

## MAIN CHALLENGES

**Generating**  
competencies in field  
of ice engineering  
research

**Establishing**  
cooperation with  
universities, research  
and technology centers  
of Asia Pacific Region  
and other territories

**Discovering**  
young talents  
interested in scientific  
and innovation  
activities

**Selecting**  
candidates for studying  
in FEFU School of  
Engineering on Master  
Degree and Post  
Graduate programs



Russia is a great maritime country washed by three oceans. Due to its favorable geopolitical location, the Pacific coastal area is greatly important for development of the country. In recent years, the Far Eastern territories have become a priority area of development, including exploration of oil and gas resources in the Sea of Okhotsk.

Since 1960s, the scientific researches in the area of hydraulic engineering in the Far East of Russia were closely related to the Department of Hydraulic Engineering at Polytechnic Institute of FEFU (former Department of Hydraulic Engineering at the Far Eastern Polytechnic Institute in 1957-1992, the Far Eastern National Technical University in 1992-2011 and the Department of Hydraulic Engineering and Theory of Buildings and Construction at School of Engineering of FEFU 2011-2019).

These activities based on fundamental studies were carried out by the group of hydro-engineering researchers with the key technologies in accordance with the Russian Federation's scientific and technical policy in the areas of information and telecommunication systems development, development of transportation technologies, and the World Ocean resources exploration. Among the gifted scientists well-known in the global academic community there is Prof. Alexander T. Bekker, an excellent director, theoretical and practical scientist, head

## RUSSIAN FAR EASTERN RESEARCH SCHOOL OF MARINE ENGINEERING

of scientific school for the World Ocean exploration, marine hydraulic engineering and sea ice engineering.

With his leadership, the global scientific researches were carried out (such as mathematical models for offshore oil and gas structures and estimation of ice loads; unique full-scale and laboratory experiments; original methods for ice floe strength calculations and its inhomogeneity; researched and tested theoretical methods for the sea ice abrasion depth calculation of concrete offshore structures; theoretical investigations of the ice dynamics impacts on the offshore facilities, and etc.).

These scientific researches stimulated development of knowledge on the ice cover, its impacts on offshore structures and its exploration.

Due to the numerous publications and participations in various international conferences and workshops, the scientific school of marine hydraulic engineering became well known among Russian and foreign scientists.

Along with the offshore ice engineering researches a large set of studies on marine hydraulic engineering issues was performed. At present, the scientific school of marine hydraulic engineering continues its studies on offshore structures durability, safety issues and economical aspects of continental shelf exploration and use of renewable energy sources. Main research methods are represented by mathematical modeling, theory of probability and mathematical statistics, physical modeling, extensive field studies, IT and geo-informational technologies, etc.

The school researchers have over 500 papers published, including

150 papers published overseas, and they obtained over 50 patents for the inventions, made over 100 scientific presentations at the international conferences.

The School established scientific cooperation with many local and international science and technology centers, academic communities, universities, companies, public organizations.

Members of the scientific school continuously participate in various international conferences and symposiums, such as ISOPE, PACOMS, OMAE, IAHR, POAC, OMS, RAO, POC, annual «The Sea of Okhotsk and Sea Ice» symposium (Japan), etc. Cooperation was established with the universities of the USA, Japan, Norway, the Republic of Korea, China, and Canada. Gifted post graduate and undergraduate students are awarded with medals and grants, including governmental and international grants, join international educational programs and internships overseas at the universities of the Republic of Korea, Japan, Taiwan, the USA, and Norway, participate in the international conferences and workshops, win Russian research contests.

Large amount of the applied researches and close relations with industry are main features of the scientific school of marine hydraulic engineering over 50 years.

These researches based on fundamental achievements in various scientific areas have always met real practical demands.

Considerable progress of the scientific school of marine hydraulic engineering is a result of its high scientific potential, ability of quick response to real needs of marine construction in the Far Eastern region and high competitiveness of the researches.

Nature of impacts from the ice-ridges and other ice features has its own specificity that should be considered in development of effective design technologies for the Arctic offshore structures protection. Parameters of the drifting ice determine the constructional solutions for maritime facilities.

With A.T. Bekker's leadership, our research group carried out theoretical fundamental and applied researches on probabilistic description of the drifting ice cover and its impacts in order to provide structural safety of the offshore structures. Methods for optimization and reliability of the offshore structures in the Arctic seas were developed. The researchers created technologies for the offshore structures protection from the ice abrasion, icing, technologies for computer simulation of the ice cover impacts on structures and facilities.

The algorithms were developed for probability calculation of the drifting ice features (ice fields, ice ridges, hammocks) impacts on the offshore platforms, underwater pipelines, and other engineering facilities. The functions of extreme ice loads distribution in conditions of joint influence of ice ridges and ice fields on the structures were developed, and probabilistic char-

acteristics of extreme loads were determined, as well as design values of ice loads in different periods of ice condition frequency.

Process of "ice-concrete" contact interaction is going under resultant velocity of the ice sliding over the concrete and it is characterized by continuously changing contact pressure, which is similar to the ice force resulted in destruction of ice crystals that scratch concrete surface and slowly damage it by knocking concrete particles out of the surface.

In 2004-2014, the theoretical and experimental researches on calculation of the ice abrasion depth with specially designed testing rig were carried out. Software for the ice influence calculation, including marine hydro-and-climatic nature data for the certain areas of construction (Sakhalin Island oil fields, lighthouse areas in the Gulf of Bothnia), were developed. The laboratory experiments on ice abrasion with set amount of cycles including concrete testing samples were carried out, the empirical abrasion models for the concrete of various composition were developed, and the annual abrasion of structures was calculated.

Theoretical researches of the interaction processes in the "ice-concrete" system were carried out; the mathematical model for description of intensively deforming conditions in the contact area of the investigated objects was developed. Analysis of this model revealed main factors affecting the intensity of concrete structure failure that, in turn, helped to develop concrete composition of high durability and with high level of resistance to ice abrasion.

Since 2017, scientists from the Polytechnic Institute have been sent on a few research expeditions to the Arctic every year. The expedition lasts from 5 to 9 months. During this time, scientists conduct a series of studies on Arctic ice and process the results.

The results obtained will help determine the working conditions for prospecting and exploration drilling and further development of the field, will be used in the design of offshore infrastructure and a hydrocarbon transportation system.





The course introduces the problems of ice mechanics to the students and provides with the experience of operating research equipment in the laboratory and in the field conditions. The course includes lectures on basic concepts of ice mechanics and ice interactions with offshore structures and ships, lectures about standards of Russia for the calculation of ice loads on offshore structures, includes laboratory and field activities in the Laboratory of Ice Studies (FEFU) and in the bay near FEFU campus. Prior to the field activities, special lectures introduce the equipment (used for the measurements of characteristics and strength of sea ice, ice hardness measurements by drop ball technique, etc.) to the students.

#### LEARNING OUTCOME

- basic understanding of ice physics and mechanics;
- basic skills for ice loads calculation of offshore structures;
- basic understanding on how the physical environment influence on ice loads and how structures respond;
- skills in operation of the equipment used on-site and in the laboratory for defining ice properties;
- skills in carrying out a test on physical and mechanical properties of ice.

**The Winter Course will be held on JANUARY 25-30, 2021.**

**Language:** English.

**The attendance fee:** 55 000 RUB/person

**Deadline for attendance fee:** January 17, 2021

P	Program	Attendance fee includes:	
N	Topics	Hours	
1	<b>Theory about Oil&amp;Gas Field Development on the offshore of The Arctic/Far-Eastern Seas:</b> <ul style="list-style-type: none"> <li>- Offshore structures;</li> <li>- Ice Physics;</li> <li>- Ice formation physics;</li> <li>- Freshwater and sea ice;</li> <li>- Ice growth in nature;</li> <li>- Ice Types in nature; Ice sheets</li> <li>- Glaciers and icebergs;</li> <li>- Sea ice descriprion and morphology (ridges);</li> <li>- Ice action on marine engineering structures;</li> <li>- Ice abrasion theoretical and experimental study;</li> </ul>	24	<ul style="list-style-type: none"> <li>- lectures, laboratory and field tests;</li> <li>- arrival and departure accompaniment services;</li> <li>- coffee breaks;</li> <li>- lunch on field test days;</li> <li>- insurance for field test days;</li> <li>- safety and security arrangements during field tests;</li> <li>- rental of protective winter clothing and shoes for field tests;</li> <li>- visa support by letter of invitation issued by Russian Migration Service.</li> </ul>
2	<b>Practical Basis for Determination of Ice Loads and Impacts</b> <ul style="list-style-type: none"> <li>- Underwater Pipelines: Design Principles in ice conditions;</li> <li>- Navigation features for Ice class vessels;</li> <li>- Ice mechanical properties (Compressive loading, Uniaxial and Multi-axial, Deformation, creep and strength, Tensile loading, True tensile, flexure and shear);</li> <li>- Ice Forces;</li> </ul>	24	<p><b>Additional charges:</b></p> <ul style="list-style-type: none"> <li>- accommodation in FEFU campus, Russky Island, Vladivostok, Russia</li> </ul> <p>*Single room - 1900 RUB/night per 1 person (including VAT)</p> <p>*Double room - 3000 RUB/night per 2 person (including VAT)</p>
3	<b>Basis of The Field/Laboratory Investigations of Physical and Mechanical Properties of Sea Ice</b> <ul style="list-style-type: none"> <li>- Nonhomogeneity of sea ice test;</li> <li>- Determining the destiny, the temperature and strength of ice (take cores);</li> <li>- Experimental determination of ice strength;</li> </ul>	Field tests: 2 days	<p>Participants should require, fill in the participant information form (QR code) and send scanned copy of passport to the contact email.</p> <p>Contact email: <a href="mailto:ice@dvfu.ru">ice@dvfu.ru</a></p> <p>Ms. Elena PIPKO</p>

## LECTURERS

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WINTER COURSE



**Tatiana E. Uvarova**, Professor, Doctor of Eng.Sciences

Experiment leader

Main themes: Ice Physics. Ice action on marine engineering structures



**Egor E. Pomnikov**, Professor, Candidate of Eng.Sciences

Main themes: Probabilistic modeling of ice loads, Experimental determination of ice strength



**Olga A. Sabodash**, Associate professor, Candidate of Eng.Sciences

Main themes: Extreme ice loads on continental shelf facilities, Underwater pipelines: design principles in ice conditions, Ice structure, Salinity of ice



**Alexander E. Farafonov**, Associate professor, Candidate of Eng.Sciences

Main themes: Nonhomogeneity of sea ice test



**Aleksey A. Shmikov**, Scientific researcher

Main themes: Offshore structures



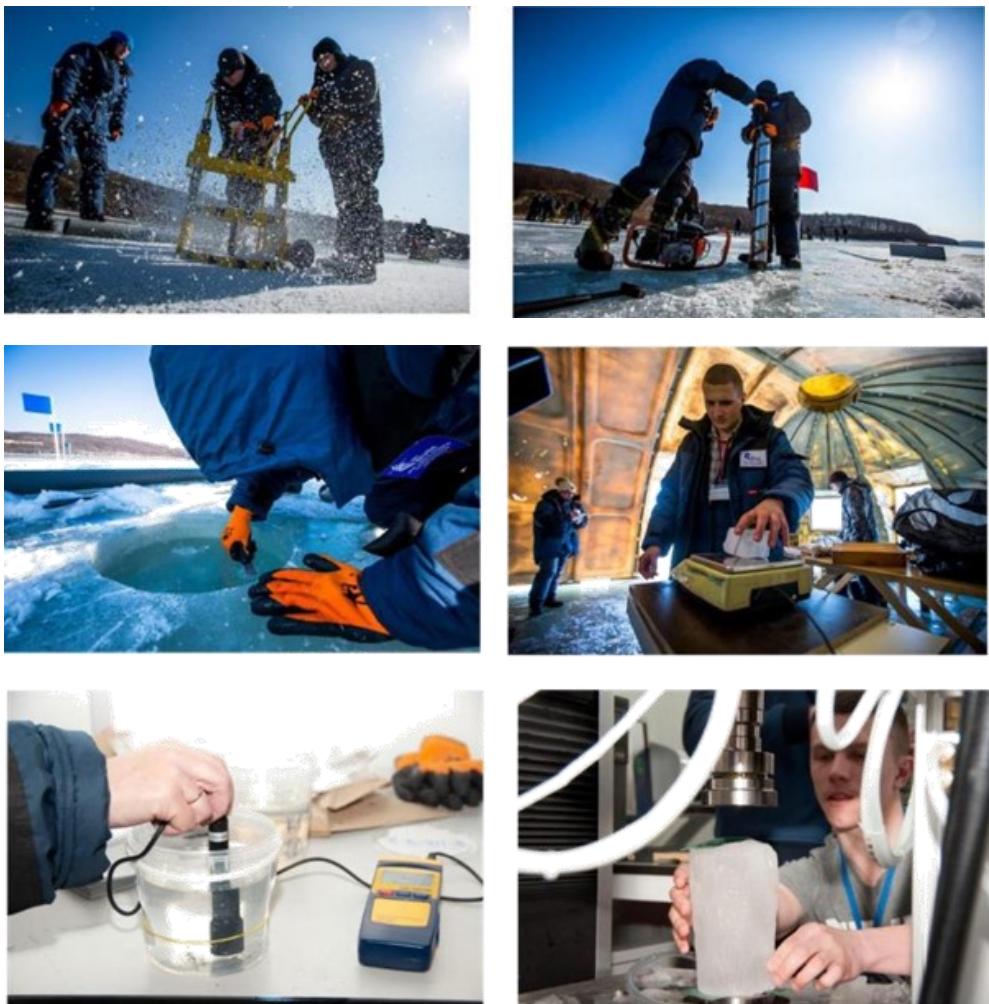
**Maxim V. Kitaev**, Associate professor, Candidate of Eng.Sciences

Main themes: Navigation features of Ice class vessels



**Pavel V. Anokhin**, Scientific researcher

Chief Technical Specialist for field tests



## JOIN THE “ICE MECHANICS-2021” WINTER COURSE

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