



N.G. Kosareva

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## **REGULATION ON INTERNATIONAL PUBLIC COMPETITION OF GRADUATE QUALIFICATION WORKS**

### **1. GENERAL PROVISIONS**

1.1. The following terms and definitions are used in this Regulation:

GQW – graduate qualification work(s) (as part of a term/graduation thesis (project), master’s, candidate’s, doctoral dissertation), as well as other creative work(s) performed as a research or other project, or as an individual initiative.

Assignment – set of conditions established by this Regulation in terms of requirements for the type, subject matter and content of the GQW, as well as the design (presentation) and execution thereof.

Commission – collegial body created by the Organizer of the Competition, which checks the eligibility of persons to participate in the Competition, evaluates the GQW based on the criteria and draws up the rating of such works, submits to the General Designer the advisory conclusion on the results of the assessment of works.

Competition – public competition of graduate qualification works performed by a Participant on one of the topics (as from the list of choices recommended in Annex 1 to this Regulation, or independently proposed on an initiative basis, aimed at solving problems in the field of string technologies and string transport), meeting the conditions and requirements stipulated by this Regulation and Chapter 56 of the Civil Code of the Republic of Belarus (hereinafter referred to as the Civil Code).

Assessment criteria – the features stipulated by this Regulation, in accordance with which the evaluation of the GQW and the determination of the Winner and Awardees of the Competition are carried out.

Award – a reward in cash or in kind, paid (issued) to the Winner and Awardees of the Competition.

Winner – the Participant (author and thesis mentor of the GQW), whose work, as on the basis of the final decision of the General Designer, complies with the assessment criteria (the highest number of points) and the task of the Competition.

Awardees – the Participants (authors and their scientific supervisors), whose GQW, on the basis of the final decision of the General Designer, took the 2nd and 3rd places, respectively.

Regulation – the present Regulation on the International Public Competition of GQW.

Participants – the persons (authors and their scientific supervisors), who submitted

the GQW, which meet the requirements established by this Regulation and are belonging thereto, to participate in the Competition.

1.2. Other terms and definitions used in this Regulation shall be construed as defined in the Regulation per se. If there are no definitions of certain concepts in the Regulation, such terms shall be interpreted in accordance with the common meaning.

1.3. The Organizer of the Competition is the scientific organization, Unitsky String Technologies, Inc., registered 12.02.2015 by the Minsk City Executive Committee under TRN 192425076, located at: 222838, Republic of Belarus, Minsk region, Pukhovichi district, 35 Novosyolki Rural Council, Zorny Shlyakh St. area, Maryina Gorka; scientific organization accreditation certificate dated 20.04.2022, No.272.

1.4. This Competition is open. The proposal of the Organizer of the Competition to take part therein is addressed to everyone by announcement in mass media and the Internet.

1.5. The announcement of the Competition is posted in the public domain on the Internet at <https://ust.inc/> in the “News” section. The announcement of the Competition may be placed in other mass media, including the print media.

1.6. Participation in the Competition does not require a fee or other actions, except for the requirements regarding the procedure for preparing and submitting the GQW, as well as the requirements for preparing the application for participation.

1.7. The Competition shall be deemed invalid in case of filing, till 01.10.2023 (inclusive), to the Organizer in total of less than 5 (five) applications for participation from various persons.

## **2. SOCIALLY USEFUL GOALS OF COMPETITION**

2.1. The Competition is aimed at achieving the following socially useful goals:  
stimulating the development of scientific research by qualified specialists - representatives of scientific and educational, production, design-construction and other industries;

ensuring the development, improvement and mass popularization of string transport technology, which completely meets the strictest requirements of energy efficiency, environmental friendliness, optimization of resource- and materials intensity, transport safety, and economic efficiency;

driving attention to breakthrough innovative transport technologies, namely – string transport systems, and shaping professional orientation of students of higher education institutions, as well as students of secondary special and general educational institutions;

use of scientific ideas, concepts, hypotheses, etc. in the development and construction of string transport systems in order to preserve the biological diversity of the planet Earth, water and land resources;

focusing public attention on the technogenic problems caused by the use of existing transport systems and vehicles, and developing ways to solve them.

## **3. TERMS OF PARTICIPATION IN COMPETITION**

3.1. Persons, regardless of their citizenship, who have reached the age of eighteen years old, are allowed to participate in the Competition. Participants of the Competition can

be legitimate students of any training courses, undergraduates, graduate students, doctoral students, scholars. It is desirable, but not necessary, for the Participant to have scientific supervisor.

3.2. The employees of the Competition Organizer – Unitsky String Technologies, Inc. – are not eligible to apply for participation in the Competition.

3.3. Each Participant has the right to submit an unlimited number of GQW to the Competition. The topics of the declared GQW may be either from the list of those recommended for choice from Annex No.1 to this Regulation, or proposed by the Participants individually on an initiative basis (without the consent of the Organizer), provided that they are aimed at solving problems in the field of string technologies and string transport. For each GQW, a separate Application for Participation is prepared and filed by the Participant.

3.4. The form of the Application for Participation is presented in Annex No.2 to this Regulation.

The Application for Participation must be signed by the Participant (the author and his/her scientific supervisor). A scanned copy of the signed Application must be emailed at [science@unitsky.com](mailto:science@unitsky.com). The subject line of the letter shall contain the wording “Competition GQW-2023”.

3.5. The letter should also be attached directly by the work itself (GQW) in one file or archive (in one of the following formats: DOC, DOCX, RTF).

**3.6. Requirements for preparation of the GQW:**

the work represents a structured and logically completed study, which includes the following sections: title page (form – at the discretion of the Participant); content; introduction; description of problems; setting the target and the tasks to be solved; the main part describing the proposed scientifically-based solutions; conclusion; list of sources; programs;

the text of the submitted materials is typed in MS Word in Times New Roman font, size 14 pt.; A4 format, book orientation, line spacing – single, width alignment (for main text). The indentation of the red line is 1.25 cm. Fields: upper, lower – 2 cm, left – 3 cm, right – 1 cm. Pages are not numbered;

volume (number of pages) of GQW is not regulated;

it is recommended to use graphic material (figures, tables, diagrams, etc.) with executed signatures.

**3.7. GQW written in Russian or English are allowed to participate in the Competition.**

3.8. By submitting the Application for Participation in the Competition with the attached GQW, the Participant guarantees that:

the work was performed by him/her personally/in collaboration;

citations given in the GQW have references to primary sources;

photo, video, graphic materials and illustrations contain indications of primary sources;

materials that do not have references to primary sources are the result of the creative work of the author him- /herself.

3.9. If the Participant fails to comply with the requirements provided for in pp.3.4, 3.5, 3.7 of the Regulation, the Application for Participation shall be considered unfiled. In

case of non-compliance by the Participant with the requirements for preparation of the GQW provided for in p.3.6 of the Regulation, the Organizer of the Competition has the right to reject the Application for Participation.

3.10. If gross copyright violations are detected, such as borrowing works not belonging to the author in the entirety or their separate significant fragments, without references to primary sources, etc., the Application for Participation by the Organizer of the Competition is not accepted, and if such Application was accepted before the moment of detection of the corresponding violations, – canceled.

#### **4. TIME FRAME OF COMPETITION**

4.1. The Application for Participation in the Competition must be filed not later than October 1, 2023. The date of filing by the Participant of the Application is the date of sending materials by e-mail and acceptance of the uploaded information by the system.

4.2. Summing up the results of the Competition is carried out not later than November 15, 2023 with the publication of information in open access on the Internet at <https://ust.inc/> in the “News” section.

4.3. If the Participant sends the Application later than the deadline specified in Clause 4.1 of this Regulation, the Application shall be considered unfiled.

#### **5. ASSIGNMENT FOR PARTICIPATION IN COMPETITION**

5.1. The Assignment for Participation in the Competition is the Participant's scientific research and preparation of GQW in the field of string transport and string technologies.

5.2. Preparation of GQW on the same topic by different Participants is allowed.

5.3. The sectoral scientific and thematic affiliation of the GQW is limited by Clause 3.3 hereof.

5.4. The filed hereto GQW should have been completed no more than 3 (three) years prior to this Competition.

5.5. In case of non-compliance with the terms of the Assignment specified in Clauses 5.1, 5.3, 5.4 of the present Regulation, the submitted Application shall be considered unfiled.

#### **6. CRITERIA AND PROCEDURE OF ASSESSMENT OF GQW**

6.1. To evaluate GQW, a Commission is created by the Organizer of the Competition.

6.2. The composition of the Commission shall be determined by the Organizer of the Competition based on the subject matter and sectoral scientific affiliation of the GQW submitted by the Participants.

6.3. The Commission may include qualified specialists (employees) of Unitky String Technologies, Inc., as well as other independent specialized specialists from other organizations, who are not interested in the result of this or that Participant.

6.4. The Organizer of the Competition imposes no restrictions as to the number of

appointed Members of the Commission. The number of Members of the Commission is determined based on the number of submitted GQW and their scope, both in general and in part of each individual GQW.

6.5. The following assessment criteria shall be taken into consideration by the Commission and the General Designer of the Organizer of the Competition when evaluating the submitted GQW:

- novelty;
- validity;
- compliance with the topic of work;
- profundity of disclosure of the topic;
- feasibility;
- use of software products;
- quality of presentation.

Each of these criteria has an equal degree of influence on the overall assessment of the work. Definition (detailed explanation) of each of the listed criteria is given in Annex No.3 hereto.

6.6. Each Participant shall be assessed by the Commission for each of the 7 (seven) criteria specified in Clause 6.5, from 0 to 10 (where 0 is the lowest value, 10 is the maximum), after which, separately for each Participant, the scores shall be summed up by simple addition as total score (0 is the minimum possible value, 70 is the maximum).

It is permissible to evaluate a Participant by several different experts (members of the Commission). In this case, the evaluation results (in points) for each of the criteria are determined as the arithmetic mean of the sum of such assessments (points) by various experts.

The Commission shall prepare an opinion that reflects the results of the assessment (in points) for each of the Participants, including their respective rating in descending order: the Participant with the highest number of points takes first place in the rating (and so on). Participants who score the same number of points rank the same position in the rating.

6.7. Based on the results of its work, the Commission shall submit to the General Designer of the Organizer of the Competition the recommendation conclusion with general rating of the Participants of GQW (with detailed explanation separately for each of the criteria).

6.8. The General Designer of the Organizer of the Competition will determine the Winner and Awardees of the Competition based on the results of the study of the GQW of the Participants and the materials presented by the Commission, taking into consideration his own inner conviction.

## **7. PROCEDURE FOR ANNOUNCEMENT OF RESULTS OF COMPETITION**

7.1. The announcement on the results of the Competition, including on the Winner and Awardees (their scientific supervisors), is posted by the Organizer in the public domain on the Internet at <https://ust.inc/> in the "News" section not later than November 15, 2023.

7.2. The Organizer of the Competition, in its sole discretion, may additionally notify the Winner and Awardees on the results of the Competition via e-mail addresses or other contact details submitted by them.

## 8. AWARD

8.1. The Winner of the Competition (the author and scientific supervisor of the GQW) shall be paid the following monetary remuneration:

the author of the GQW – monetary remuneration in Belarusian rubles in the amount equivalent to 3,000 (three thousand) US dollars at the exchange rate of the National Bank of the Republic of Belarus on the day of payment;

the scientific supervisor of the GQW – monetary remuneration in Belarusian rubles in the amount equivalent to 3,000 (three thousand) US dollars at the exchange rate of the National Bank of the Republic of Belarus on the day of payment.

8.2. The Participant who takes the 2nd place in the Competition shall be paid the following monetary remuneration:

the author of the GQW – monetary remuneration in Belarusian rubles in the amount equivalent to 2,000 (two thousand) US dollars at the exchange rate of the National Bank of the Republic of Belarus on the day of payment;

the scientific supervisor of the GQW – monetary remuneration in Belarusian rubles in the amount equivalent to 2,000 (two thousand) US dollars at the exchange rate of the National Bank of the Republic of Belarus on the day of payment.

8.3. The Participant who takes the 3rd place in the Competition shall be paid the following monetary remuneration:

the author of the GQW – monetary remuneration in Belarusian rubles in the amount equivalent to 1,000 (one thousand) US dollars at the exchange rate of the National Bank of the Republic of Belarus on the day of payment;

the scientific supervisor of the GQW – monetary remuneration in Belarusian rubles in the amount equivalent to 1,000 (one thousand) US dollars at the exchange rate of the National Bank of the Republic of Belarus on the day of payment.

8.4. In case of co-authorship (including joint scientific supervision of the GQW), the remuneration stipulated by Clauses 8.1-8.3 is paid to each of the co-authors (scientific supervisors) in equal shares.

8.5. In case the Winner of the Competition is a foreign citizen, monetary remuneration may be paid in foreign currency (US dollars or other currency equivalent to the amounts specified in Clauses 8.1-8.3 of the present Regulation).

8.6. Payment of remuneration is carried out on the basis of the decision of the General Designer, which reflects information about the Winner and Awardees of the Competition (authors and scientific supervisors of the GQW) and the amount of remuneration paid. The decision of the General Designer shall be approved by the General Director of the Organizer of the Competition.

8.7. Cash remuneration shall be paid via bank transfer of the Organizer to the settlement account of the Winner (Awardees) of the Competition within 30 work days after submission of all necessary documents requested by the Organizer of the Competition to pay the Award.

8.8. Commission expenses for performing banking operations to transfer funds from the settlement account of the Organizer of the Competition to the settlement account of the Winner (Awardees) shall be paid by the Organizer of the Competition in the country of its registration, by the Winner (Awardees) of the Competition – in the country of their

registration/residence/of main activity (with the exception of the Republic of Belarus).

8.9. The Organizer of the Competition, in its sole discretion, has the right to additionally provide the Winner (Awardees) of the Competition with other incentive prizes (books, certificates, diplomas, invitation to visit the uST group of companies in Belarus, etc.).

8.10. The organizer of the Competition, in its sole discretion, has the right to offer jobs at Unitsky String Technologies, Inc., to individual Participants in accordance with the labor legislation of the Republic of Belarus. This Clause does not impose any obligation on the Organizer of the Competition to provide such job (employment).

8.11. Travel and other expenses, including accommodation expenses, related to the arrival in the Republic of Belarus, any other expenses related to receiving the Award/Incentives not mentioned in this Regulation, the Participants (including the Winner, the Awardees) of the Competition shall bear on their own. The above-mentioned expenses are not compensated for by the Organizer of the Competition.

8.12. In accordance with Art. 23, 216 of the Tax Code of the Republic of Belarus, the Organizer of the Competition, in the process of the payment (issuance) of the Award, acts as withholding agent and fulfills the obligation to calculate and pay the amount of income tax and other mandatory payments withheld from natural person in relation to the income of that person, the source of which is the withholding agent. Proceeding from the above mentioned, taxes and other obligatory payments will be deducted from the amount of remuneration by the Organizer of the Competition, in accordance with the procedure stipulated by the legislation of the Republic of Belarus.

8.13. In accordance with Art. 294 of the Civil Code, the obligation to pay the Award may be assigned by the Organizer of the Competition to a third party. In this case, the Winner and Awardees are obliged to accept such fulfillment as performed by a third party in place of the Organizer of the Competition.

8.14. In case the Winner (Awardees) of the Competition do not claim the Award/Incentive or refuse (do not accept) the Award/Incentive, including by not submitting the documents requested for the transfer of remuneration, within 3 (three) months from the date of announcement of the results of the Competition, the specified Award/Incentive remains in the ownership of the Organizer of the Competition and is not subject to further payment (issuance).

## **9. FINAL PROVISIONS**

9.1. By submitting the Application for Participation in the Competition, the Participant confirms that he/she is familiar with the present Regulation and accepts all the conditions contained therein, and also does not claim to receive any payments (including royalties), except for the payments specified in clauses 8.1-8.3 of this Regulation.

9.2. Personal data of the Participants shall be processed by the Organizer of the Competition – Unitsky String Technologies, Inc. – on the basis of Clause 16 of Part 1, Art. 6 of the Law of the Republic of Belarus dated 07.05.2021 No.99-3 “On Protection of Personal Data”, when the Participant sends a scanned copy of the signed application for participation (Annex No.2). The Participants’ personal information is processed for the following purposes:

verification of the eligibility of persons to participate in the Competition, their admission, organization of the Competition (evaluation of the Participants' works, compilation of rating, determination of the Winner and Awardees);

ensuring communication with the Participants;

posting information on the results of the Competition in the public domain on the Internet website <https://ust.inc/> in the "News" section, as well as, at the discretion of the Organizer of the Competition, in other mass media, including the print media.

9.3. By submitting the Application for Participation in the Competition, the Participant confirms that the information provided in the application and the GQW does not contain trade secrets, top-secrets (national and official), personal, family or other secrets of third parties.

9.4. The Organizer has the right to make changes and additions to the terms of the Competition, including this Regulation and its annexes, which are an integral part of it, with information about it on the Internet at <https://ust.inc/>, as well as in the media in which it was announced.

9.5. In all other matters not covered by the present Regulation, as well as to any legal relations arising on the basis thereof, the law of the Republic of Belarus shall be the applicable.

9.6. This Regulation will be published in the public domain on the Internet on the website <https://ust.inc/> in the "News" section, and may also be posted by the Organizer of the Competition in other mass media.



**Sample list of topics for preparation by Participants of GQW**

No., title of project (topic) by industry	Problems (justification) of the need to elaborate the topic
<b><i>Rolling Stock by Unitsky String Technologies (uST)</i></b>	
1. Search for innovative / efficient methods of high-capacity current transfer from metal rail via wheel to transport past hub bearings	<p>The traditional method of arranging current transfer from wheel/rail contact to the electrical equipment system of the vehicle by installing a brush unit has a number of restrictions. First of all, as follows:</p> <ul style="list-style-type: none"> <li>- significant dimensions of the unit (the size and number of brushes for current transfer of the order of 400A do not allow it to be built into a wheel of small (less than 300 mm) diameter;</li> <li>- formation of products of brushes wear in a limited space, which requires additional costs for control and maintenance of cleaning in hard-to-reach places.</li> </ul> <p>In this regard, scientific (innovative) solutions for the arrangement of current transfer are required</p>
2. Development of block diagram of programmable logic controller with secured safety integrity level not lower than SIL 2	<p>Currently, purchased controllers are used to control rolling stock systems, and their configuration is not an optimal solution in the development of electrical equipment. The use of in-house developed controllers will allow to more optimally build the architecture of the control system and the distribution of its resources, while maintaining safety integrity indicators.</p> <p>During the task completion, it is necessary to develop a block diagram of the controller, select its components, the software development environment of the lower and upper levels and justify the achieved level of safety integrity</p>
3. Development of solutions for reducing acoustic noise from the vehicle interior air conditioning system	<p>During the operation of the air conditioning system, noise from a fan (about 90 dBA) located outside the vehicle cabin spreads through the air ducts, enters the cabin and reduces the level of comfort of passengers.</p> <p>Efficient solutions are required regarding the geometry of air ducts, materials used, fan design, which reduce the noise level in the cabin to 60 dBA without reduction of the volume of air supply and significant increase in the dimensions of the air conditioning system</p>
4. Preparation of proposals for arrangement (of device or complex devices) for self-evacuation of passengers from the second level transport (string transport, monorail, cable transport)	<p>Emergency situations are possible when the stay of people inside the interior of the vehicle is dangerous for their life and/or health, and rescuers do not have time to arrive. Due to the fact that the transport is located high above the ground surface (at least 10 m), special means are needed to leave the cabin. In this regard, one new device or set of devices, which may include already known solutions, should be proposed in order to eliminate the problem.</p> <p>In this case, the following should be considered:</p> <ul style="list-style-type: none"> <li>- possible composition of passengers by age, physical limitations and other parameters;</li> <li>- presence and time of exposure to various harmful factors (smoke, high/low temperature, etc.), etc.</li> </ul> <p>It must also be considered that evacuations can occur over: urban development; road; water surface; forest area; hillside, etc.</p>
5. Concept of evacuation of passengers from the second level transport (string transport, monorail, cable transport)	<p>Second level transport can pass over various territories and overcome obstacles inaccessible to classical land or another rescue transport. This circumstance can slow down or completely exclude the access of rescuers to an emergency vehicle for the evacuation of passengers,</p>

No., title of project (topic) by industry	Problems (justification) of the need to elaborate the topic
	<p>if possible difficulties and measures to solve them are not foreseen in advance.</p> <p>In this regard, it is necessary: to determine the situations, wherein the evacuation of passengers from the vehicle may be required; describe evacuation scenarios, select and justify a set of proposed technical means and measures; introduce additional requirements for the design of transport and other components of the transport complex.</p> <p>The following should also be considered:</p> <ul style="list-style-type: none"> <li>- possible composition of passengers by age, physical limitations and other parameters;</li> <li>- presence and time of exposure to various harmful factors (smoke, high/low temperature, etc.)</li> </ul>
<p>6. Search for effective methods to maintain the required coefficient of wheel-to-rail friction to maintain traction in order to move at high speed regardless of external conditions (in case of frost formation, snow cover, etc., on the rail head) in all operating modes (transient modes: acceleration, slope movement, braking)</p>	<p>A conventional method of arranging to maintain the required coefficient of wheel-to-rail friction (ensuring no slippage) to realize vehicle traction is provided by measures such as:</p> <ul style="list-style-type: none"> <li>• maintaining the surfaces of the rail and wheel with the required cleanliness and evenness of the surfaces;</li> <li>• sweeping (clearing) and heating of the rail at low temperatures, preventing icing, ice-glazing (including cleaning from oil pollution);</li> <li>• sand supply under wheelsets;</li> <li>• change of operating modes;</li> <li>• provision of appropriate axle load on wheelsets, etc.</li> </ul> <p>The above-mentioned measures are not sufficient and effective, since they require additional costs for monitoring the state of the rail head coating, and additional maintenance.</p> <p>In this regard, scientific (innovative) solutions are required to ensure that the required friction coefficient is maintained.</p> <p>It is required to ensure moment from 1,300 to 2,170 N*m at speed of movement up to 500 km/h, while the vehicle must show speedup (acceleration/deceleration) <math>a=1.0 \text{ m/sec}^2</math> over the entire speed range.</p> <p>For calculations, the following are assumed: rail and wheel materials – steel; rolling surface width 40-80 mm; wheel load 15-25 kN.</p>
<p>7. Tackling the problem of ice removal from uST track structures with use of innovative solutions on rolling stock</p>	<p>In the cold season, with the long absence (zero movement) of rolling stock on track structure, as well as due to adverse weather conditions, the frequent formation of ice crust of various thickness is a challenging issue, which does not allow to ensure the proper contact and friction of the steel wheel with the rail, and may lead to emergencies.</p> <p>In this regard, scientific (innovative) solutions are required in relation to units of rolling stock, which will allow the rapid removal of the ice layer and contribute to the unhindered movement of transport along the track structure (rolling surface).</p> <p>For calculations, the following are assumed: rail and wheel materials – steel; rolling surface width 40-80 mm; wheel load 15-25 kN; elevation above ground level – 10 m; climate zone – temperate</p>
<b><i>Solutions in Materials Science</i></b>	
<p>1. Scientific justification for the use of ultra-strong materials to create lightweight prestressed elements of long-span structures</p>	<p>Steel ropes used as prestressed elements of track structures do not permit full usage thereof in the manufacture of long-span structures with insignificant sagging. It is required to submit justified proposals in the form of materials (with density of less than <math>5,000 \text{ kg/m}^3</math>) and methods of fastening thereof for tensioning, allowing to ensure tensile stresses of more than 2,000 MPA. At the same time, materials</p>

No., title of project (topic) by industry	Problems (justification) of the need to elaborate the topic
	should be capable to be used for the manufacture of ropes (rods, bands) with length of more than 1,000 m
2. Development of methods to improve corrosion resistance and abrasion resistance of string rails	During operation, the head of string rail is subjected to substantial impacts: high contact stresses (about 500 MPA) in a wide temperature range (from 60 degrees in the freezing cold to 60 degrees of heat in the sun) and air humidity of more than 70 %. It is vital to offer a technology for applying a protective coating in field conditions and a corrosion protection material that provides high hardness (40 HRC), wear resistance, durability and adhesive strength
3. Solving the icing problem of track structures of uST string transport directly on the rolling surface	<p>In the cold season, with the long absence (zero movement) of the rolling stock on the track structure, as well as due to adverse weather conditions, the frequent formation of ice crust of various thickness is a challenging issue, which does not allow to ensure the proper contact of the steel wheel with the rail, which may lead to emergencies.</p> <p>In this regard, scientifically based approaches are needed in the field of materials science, chemistry, etc., to eliminate such ice crust on the rolling surface (for various types of track structures), along which the rolling stock on steel wheels moves.</p> <p>For calculations, the following are assumed: rail and wheel materials – steel; rolling surface width 40-80 mm; wheel load 15-25 kN; elevation above ground level – 10 m; climate zone – temperate</p>
<b><i>Architecture and Design</i></b>	
1. Development of design option for one of the infrastructure elements of the uST transport and infrastructure complex	It is required to elaborate design option for open-type single-track passenger station for UniLight suspended vehicle, designed to be located in the current development as illustrated by one of the major cities in Central Europe with height of up to 15 meters to the rail head
2. Development of design option for one of the infrastructure elements of the uST transport and infrastructure complex	It is required to elaborate design option for closed-type single-track passenger station for UniLight suspended vehicle, designed to be located in the current development as illustrated by one of the major cities in Central Europe with height of up to 15 meters to the rail head
3. Development of design option for one of the infrastructure elements of the uST transport and infrastructure complex	It is required to elaborate design option for closed-type single-track passenger station for Unibus suspended vehicle, with built-in public facilities, designed to be housed in park areas with height of up to 6 meters to the rail head
4. Development of design option for one of the infrastructure elements of the uST transport and infrastructure complex	It is required to elaborate design option for single-track passenger station for Unibus suspended vehicle, designed to be housed in park areas with height of up to 6 meters to the rail head
5. Development of design option for one of the infrastructure elements of the uST transport and infrastructure complex	It is required to elaborate design option for single-track passenger station for Unibus suspended vehicle, designed to be built in Yamalo-Nenets Autonomous Okrug of Russian Federation, with height of up to 15 meters to the rail head
6. Development of design option for one of the infrastructure elements of the uST transport and infrastructure complex	It is required to elaborate design option for single-track passenger station for Unibus suspended vehicle, combined with public transport stop, designed to be built in current development in large cities (at the choice of the Participant) with height of up to 18 meters to the rail head
7. Development of design option for one of the infrastructure elements of the uST transport and infrastructure complex	It is required to elaborate design option for open-type single-track passenger station for Unibus suspended vehicle, combined with public transport stop, designed to be built in currently developed large cities (at the choice of the Participant) with height of up to 15 meters to the rail head

No., title of project (topic) by industry	Problems (justification) of the need to elaborate the topic
8. Development of design option for one of the infrastructure elements of the uST transport and infrastructure complex	It is required to elaborate design option for open-type single-track passenger station for Unibus suspended vehicle, combined with railway transport stop, with height of up to 15 meters to the rail head
9. Development of design option for one of the infrastructure elements of the uST transport and infrastructure complex	It is required to elaborate design option for open-type single-track passenger station for Unibus suspended vehicle, combined with highway pedestrian overpass
<b><i>High-Speed Transport Complex</i></b>	
1. Solving the problem of traction power supply of uST string transport from the track structure	The power supply of unimobiles is carried out from contact line, which is «+» on one rail, and «-» on the other rail of the track structure. In this regard, scientifically based solutions in the field of energy are needed, which make it possible to provide pick-up of current transfer of the order of 400A at speeds of movement of unimobiles above 500 km/h
2. Development of materials and technology for the manufacture of wheels of high-speed transport	Currently, in classical rail transport, wheels are used that allow vehicles to move at speeds within 250 km/h. Increasing the speed to 500 km/h leads to strong heating in the contact area of the wheel-rail pair, rapid wear and destruction. It is necessary to offer materials for wheels of high-speed electric transport, providing high heat resistance at loads of 22-25 kN, wear resistance with a guaranteed mileage of 1 million km, as well as to propose a method for the manufacture of such wheels in small-scale production
<b><i>Hyper Speed Transport Complex</i></b>	
1. Provision of zero buoyancy of the tunnel of the hyper speed transport complex with consideration to external influences	The tunnel of the hyper speed transport complex has sections running in the water column of the seas and oceans. The tunnel has positive buoyancy based on its weight and size parameters. It is necessary to develop a set of technical solutions that ensure controlled near-zero buoyancy of the linear section of the track structure in the ocean with an average depth of 4 km with the provision of boundary minimum curvature radii, with consideration to external influences like ocean currents, etc.
2. Selection of protective coatings for the tunnel of the hyper speed transport complex	The tunnel of the hyper speed transport complex has sections running outdoors, underground, in the strata of sea and fresh water. It is necessary to select compositions that provide comprehensive protection of the outer layer of the linear section of the track structure against the following effects: ultraviolet light, icing, temperature drops (from -60 to +60 °C), exposure to sea and fresh water, microorganisms, flora, fauna, and humans
3. Design of connection node of the tunnel of the hyper speed transport complex to intermediate support	The linear section of the tunnel of the hyper speed transport complex consists mainly of commercially available construction material - reinforced concrete, therefore, has a large mass and relatively low strength, which must be distributed on intermediate supports. At the same time, an increase in the wall thickness of the tunnel pipe ensures the vandal and terrorist stability of the structure. It is necessary to develop a node which will ensure the perception of mass (from 200 to 600 tons) from the hyper speed tunnel and the transfer of load to the intermediate support and underlying soils. At the same time, the node must provide compensation for displacement of $\pm 50$ mm/slope $\pm 3^\circ$ /turn $\pm 3^\circ$ of the intermediate support during soil movements, for example, during an earthquake, without damage to the tunnel bearing shell
4. Design of comprehensive solution for the removal and	A hyper speed rail electric car on steel wheels (unimobile) is designed with the possibility of long-term transportation of

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utilization of heat generated by the rolling stock equipment – electric rail vehicles, in the absence of possibility of heat dissipation into atmosphere	passengers and goods in the forevacuum tunnel. Some of the equipment of the unimobile operates in an environment with pressure of 10 to 10,000 Pa, which eliminates the possibility of its effective cooling of the incoming air flow. It is necessary to develop a comprehensive solution that ensures the collection, storage and disposal of heat in the amount of 26 kW (including 20 kW – emitted from the equipment of the unimobile, 6 kW – passengers) emitted by the equipment and passengers in low pressure environment. The operation of cooling systems should have a closed circuit and exclude the discharge of liquid and solid particles into the forevacuum tunnel
<b><i>Energy Solutions</i></b>	
1. Solving the problem of traction power supply of uST string transport with energy recovery to the contact network	When speeding up, unimobiles consume energy from the contact network. With electrodynamic braking, the unimobiles generate energy from 100 to 200 kW*h (for speeds of movement up to 150 km/h), which must be transferred to the contact network and, with further acceleration of the unimobiles, transfer the received energy back from the contact network. In this regard, it is necessary to propose energy solutions that allow you to have such a recovery system and reuse energy.
2. Development of procedure for evaluation of fractional composition of coal-water slurry using rapid method	When selecting the optimal modes of operation of the electro-hydraulic shock installation in continuous operation, as well as to assess the correctness of its operation with the production of crushed coal with a fraction of the fraction 250 μm or less (in a total volume of more than 80 %), it is necessary to develop an express method for assessing the fractional composition of coal-water slurry by the size of the fractions, their proportion and homogeneity via microscopic method. Microscope operation modes, sample preparation for analysis, number of frames, substrate/medium shall be selected in this procedure (if necessary), method of taking pictures, selection of a computer program (coding it, if necessary) to evaluate the obtained images with minimal involvement of the microscope operator (i.e. take a snap, press the buttons, get data table and graphs (particle size, fraction, degree of homogeneity, area), as well as the possibility of statistical processing of one sample according to the <i>n-th</i> number of its images. The method should be tested on a large number of samples with high degree of reliability (error not more than 5 % between sampling of images of one sample/ the sampling of at least 10 images)
3. Development of coal-water slurry with specified characteristics	With the same heat of combustion, ash content, mineralogical composition, placement water content and the same preparation costs, the quality of coal-water fuel is characterized by its rheological properties – dynamic viscosity and stability. The need to create a coal-water fuel (CWF) with the maximum content of solid phase (coal) leads to a sharp increase in its dynamic viscosity. The viscosity of CWF can be reduced by the introduction of chemicals (surfactants) with an optimal combination of dispersants and stabilizers, as well as the selection of the particle size distribution of carbon particles. The dependence of viscosity on the content of the “fine” fraction and chemical additives is, as a rule, extreme in nature. Reducing the dynamic viscosity of CWF due to the use of surfactants is a rather expensive measure, since today's cost of surfactants is almost commensurate with the cost of raw materials (coal). It is known that the viscosity of CWF, as well as its stability, all other things being equal, strongly depends on the particle size distribution of coal and

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	<p>its hygroscopicity. The latter largely depends on the composition and nature of the mineral phase, which, along with surfactants, ultimately determines the rheological properties of the CWF. Thus, the task of creating a stable coal-water slurry with given rheological properties (viscosity) with maximum filling thereof with coal and minimum consumption of expensive surfactants is an urgent task.</p> <p>It is necessary to select the coal-water ratio, the fractional composition of coal, the content of additives - the minimum in quantity and low cost. The slurry should have the following properties: sedimentation resistance – at least 30 days; viscosity – in the range of 800–2000 mPa*s at shear rate 11 s<sup>-1</sup></p>
4. Development of modern methods for processing brown coals	<p>It is required to develop an innovative technology for waste-free processing of brown coals from the stage of selecting raw materials to the stage of producing finished products for agriculture, energy or ecology. When developing the technology, it is necessary to be guided by the principles of environmental friendliness, the maximum possible reduction in the formation of any waste, emissions, wastewater or, if it is impossible, to provide options for their use, as well as the preservation of natural resources (reduction of water consumption, rational use of natural resources, heat, steam, etc.). The developed technology should contain a description of all technological stages with prescribed technological modes, selected equipment options, technological scheme, technical and economic calculations, which will include productivity, cost, payback periods, etc.</p>
5. Development and practical testing of the mathematical model of rheology of coal-water slurry	<p>It is required to develop a mathematical model of the rheology of coal-water slurry in order to be able to create such slurry with the required properties. When calculating the model, it is necessary to be guided by the fact that acceptable rheological characteristics for a coal-water slurry are as follows: viscosity – in the range of 800–2000 mPa*s at shear rate 11 s<sup>-1</sup>, sedimentation resistance – at least 30 days, particle sizes (80 % or more) – less than 250 μm, ash content – not more than 35 %, humidity – in the range from 30 to 50 % (it is necessary to strive for 30 %)</p>
6. Development of method (technology) of effective ignition of coal-water fuel (CWF)	<p>CWF refers to low-reaction fuels. The main problem in CWF combustion is the low flammability at the initial combustion area; there is also a risk of loss of flame and pulling of length of the ignition area.</p> <p>Solutions are required for CWF standalone flame ignition without the use of other fuels (coal, gas, fuel oil)</p>
7. Creating a nozzle with resistance to abrasion by coal particles	<p>Regardless of the combustion method of coal-water fuel (CWF), it is supplied to the furnace through nozzles. There is a problem of providing burners that are resistant to abrasion by the coal particles included in the CWF.</p> <p>In this regard, solutions to the problem of wear of the burner feed channel are required by changing the design of the nozzles</p>
8. Selection of the most effective technology for gasification of brown coals, determination of the type of gasification plant	<p>Brown coals are highly ash, with high reactivity.</p> <p>It is necessary to select a gasification technology (compare existing methods or propose a new one), determine the best one for brown coals, and select the type of gasification plant (unit)</p>
9. Filtration of coal-water fuel (CWF) using natural filters	<p>Before feeding to the nozzles, CWF requires sufficiently high degree of cleaning from mechanical impurities. There are standard filtration (cleaning) methods based on the use of specialized equipment (filters).</p>

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	It is necessary to propose a solution to this problem based on the use of natural components involved in the filtration process: coal, soil, water, etc., in order to “loop” the process, i.e. return impurities back to the soil
10. Development of a wireless method for transmitting energy with power of the order of 100 kW	The transfer of energy to the rolling stock, which moves along the rails (regardless of the speed of movement), is currently carried out either with the help of a contact wire, or with the use of the rail itself, which leads to the rise in price thereof, as well as additional wear due to the presence of a movable electrical contact. It is necessary to propose an alternative method of efficient energy transfer (with the maximum possible efficiency) to rolling stock on steel wheels
11. Development of method for efficient use of hydrogen for electric power generation	Currently, the use of hydrogen for electric power requires the use of fuel cells (FC), which are high in cost and low in efficiency (less than 60 %). It is necessary to propose a FC design or a method for converting the energy of hydrogen gas into electric energy with efficiency exceeding 80 % for their possible use in electric transport
<b><i>Biotechnologies</i></b>	
1. Modeling trophic chains within the closed ecosystem	Due to the fact that forecasts for the development of ecosystems depend on models of the relationship of their components, and the number of components and factors affecting them is quite significant, there is a need to create operating algorithm, which on the basis of actual, practical data, will create a forecast for the development of populations and probable threats to the homeostatic equilibrium of closed ecosystems
2. Bioutilization system for organic waste of plant and animal origin	The anthropogenic load on the ecosystem is colossal. Every day, a person throws away a significant volume of organics unused in food, with a large amount of mineral and organic components, which can be effectively used to create agricultural products (composts, feeding, etc.). Animal and human waste can also be treated by similar processes (aerobic and anaerobic microorganisms) to provide safe materials that can be used, for example, in agriculture to produce various products. A comprehensive solution (technology, description of biological processes, required equipment, etc.) for bioutilization of organic waste is welcome for proposal
3. Develop the technology for creation of biofilters	The creation of renewable biofilters for the treatment of water and air is one of the most important tasks of the ecological (natural) development of the mankind. Biofilters, unlike contemporary filters, will allow not only to naturally clean air and water, but also, when used, they will be able to enter the feed base for animals by transferring pollution into useful products. In this regard, it is vital to propose the compositions of biofilters, the characteristics of the materials used, the technology for creating biofilters (air filtration from one or more components of flue gases, liquid – from sulfates, sulfites, ammonium nitrogen, nitrates, phosphates, pesticides
4. Select crops (sorghum, amaranth) that are resistant to adverse environmental factors	For the comfortable development of the mankind, the food safety of the population is vital. An effective way to achieve a balanced human diet is to use cereal crops, like, for instance, sorghum and amaranth, that are resistant to adverse agroclimatic factors. Considering the requirements, it is necessary to select them and present the results (varieties, plant seeds).
<b><i>Other Directions</i></b>	
1. Socio-economic justification of the feasibility of building the uST transport and infrastructure	With regard to the increasing relevance of the development and implementation of new types of transport systems designed to elevate the movement of vehicles to the “second level”, it is necessary to justify from the perspective of socio-economic factors the feasibility

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complex as illustrated by the example of a specific region	of constructing one transport and infrastructure complex (facility) of uST (the length and parameters of the track – at discretion of the author) using the example of a specific region (city, etc.)
2. Studies of the movement of vehicles using magnetic levitation on permanent magnets	Electrostatic (Transrapid) or electrodynamic (Maglev) suspension system is widely used in magnetic levitation transport. But such systems are quite difficult to manage, being expensive and inefficient due to significant electricity costs. It is necessary to propose an electric transport control scheme with the assistance of permanent magnets, which provides levitation at stable equilibrium of the vehicle, lateral stabilization and traction system
3. Dispatching of production processes using hybrid video recording and SCADA visualization system	<p>The crucial task is to develop a comprehensive solution for building a video registration control and production process control system with use of dispatching, through a mobile operator visualization device. That is, it is required to study the concept of combining video surveillance in the storyboard of the animated overlay of the infographic of SCADA-visualization and outputting the captured data from industrial controllers in real time with the subsequent translation of content on mobile applications.</p> <p>A well-developed proposal implies the use of:</p> <ul style="list-style-type: none"> <li>- simplest algorithms for recognition and identification of object contours (application of neural networks of artificial intelligence);</li> <li>- generation of a set of databases from the Automated Industrial Production Control System (hereinafter referred to as ACS);</li> <li>- superposition of graphic elements of SCADA system and output of current ACS values on video sequence;</li> <li>- data transmission from the server to the client over a secure Wi-Fi wireless communication channel (standard Microsoft service);</li> <li>- WEB content broadcast on the operator's mobile device with OS Android</li> </ul>



Annex No.2  
to Regulation on  
International Public Competition of  
Graduate Qualification Works

**Application form filed for participation in the Competition**

Full name of the Participant	
Date of birth	
Degree, academic title (if any)	
Place of work and/or study (with address) and position (if any)	
Mobile phone	
E-mail	
Title of GQW topic	
Full name of the scientific supervisor (if any)	
Degree, academic title of the scientific supervisor (if any)	
Place of work and position of scientific supervisor (if any)	
Date of application	

In accordance with p.9.2 of the Regulation, personal data of the Participants shall be processed by the Organizer of the Competition – Unitsky String Technologies, Inc.- on the basis of Clause 16 of Part 1, Art. 6 of the Law of the Republic of Belarus dated 07.05.2021 No.99-3 “On Protection of Personal Data”, when the Participant sends a scanned copy of the signed application for participation (Annex No.2). The Participants’ personal information is processed for the following purposes:

verification of the eligibility of persons to participate in the Competition, their admission, organization of the Competition (evaluation of the Participants’ works, compilation of rating, determination of the Winner and Awardees);

ensuring communication with the Participants;

posting information on the results of the Competition in the public domain on the Internet website <https://ust.inc/> in the “News” section, as well as, at the discretion of the Organizer of the Competition, in other mass media, including the print media.

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Signature of author / Full name of author

« \_\_\_ » \_\_\_\_\_ 2023

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Signature of scientific supervisor / Full name of scientific supervisor

Annex No.3  
to Regulation on  
International Public Competition of  
Graduate Qualification Works

**Assessment criteria of GQW by the Competition Organizer**

<b>No., criterion</b>	<b>Definition (detailed explanation) of the criterion</b>
1. Novelty	Non-standard proposed ideas (solutions) containing new scientific knowledge (information); the fundamental difference between the solutions proposed in the GQW and those analogous in the searched area, combined with a pronounced creative approach
2. Validity	Completeness and integrity of information confirming the main hypotheses in the work and the problems solved therein; the ability to verify (prove, calculate) the main conclusions presented in the work and the results obtained
3. Compliance with the topic of work	Degree of compliance of the GQW and the materials presented therein with the declared topic
4. Profundity of disclosure of the topic	Completeness of materials and information presented in the GQW to achieve the goals set in the work, to solve the occurring scientific problems
5. Feasibility	The possibility of real practical implementation of the ideas proposed in the work (calculations, new methods, etc.), incl. considering the degree of their correctness, in realization of uST transport and infrastructure solutions, in the field of string transport and string technologies in general
6. Use of software products	Complexity (in terms of quantity, quality, relevance and correctness) of use of programs, including interrelated ones, and specialized software to solve the tasks (problems) set in the work
7. Quality of presentation	Compliance of the GQW with the requirements of p. 3.6 of the Regulation and other generally accepted rules for registration of scientific works