Name of subject	INNOVATIVE TECHNOLOGIES FOR ROAD CONSTRUCTION MATERIALS (ECTS 4)
Subject/module code	**YQMIT2021**
Science taught semester (s).	3rd semester
Responsible teacher	Ganiyev Inomjon Gulomovich – head of the department "Road engineering", PhD, professor
Education language	Uzbek
Connection to the curriculum	Elective
Training hours (this including independent education)	**Total hours – 120 hours** **Contact hours – 36 hours** Lecture training hours – 12 hours Practical training hours – 24 hours **Independent education – 84 hours**
Course work	No
ECTS	4
The purpose and tasks of subject / learning outcomes	**The purpose of teaching the subject is** to develop master's students' competence in analyzing relationships between the composition, structure and performance of road construction materials, selecting innovative materials, and justifying their production and application technologies on technical, economic and environmental grounds. **The objectives of teaching the subject are** to introduce modified bitumens, modern asphalt and cement concretes, recycled materials and soil stabilization technologies; design material mixes and evaluate test results; control production quality; and adapt resource-efficient technologies to local conditions. **Learning outcomes:** 1. Explain relationships between the composition, structure and properties of road construction materials; justify selection criteria for climatic conditions and traffic loading. 2. Analyze how polymer, rubber and mineral modifiers affect bitumen and asphalt concrete properties; identify technological advantages and limitations. 3. Evaluate the technological conditions for using warm-mix asphalt, recycled asphalt, low-clinker cement concrete and stabilized soils. 4. Plan research on innovative materials; justify the control specimen, experimental factors, replicate tests and reliability of results. 5. Calculate aggregate grading and select a mix design based on the volumetric properties of the asphalt concrete mixture. 6. Interpret test data on bitumen rheology and the resistance of asphalt concrete to rutting, cracking and moisture damage. 7. Calculate quantities of recycled materials, modifiers and mineral additions; develop a process flow diagram for mixing, laying and compaction. 8. Select cement concrete and stabilized soil mixes from the supplied data; compare strength and durability results with specified requirements. 9. Compare material options by life-cycle costs and environmental indicators using the same functional unit and analysis period. 10. Critically review scholarly sources, develop an engineering solution in a small group, and present results supported by calculations.
Course content (topics)	**I. Main Theoretical Part (Lecture Sessions).** Topics: 1. Innovations in road construction materials and performance criteria

	2. Technologies for modifying bituminous binders 3. Modern asphalt concrete mix design methods 4. Resource-efficient asphalt technologies and recycling 5. Innovative cement concrete and base course materials 6. Quality management and evaluation of innovation effectiveness **II. Instructions and recommendations for organizing laboratory exercises** Laboratory work is not included in the curriculum **III. Practical training instructions and recommendations** The instructor's preparation for a practical session begins with the study of initial documents (such as the curriculum, topic schedule, etc.) and concludes with the development of a detailed lesson plan. The instructor must have a clear understanding of the objectives and tasks of the practical session, as well as the amount of work each student is expected to perform. Methodological guidelines serve as the primary instructional document for instructors in preparing and conducting practical sessions. The purpose of the practical session is to facilitate the comprehension of theoretical material, the acquisition of practical skills, the ability to consciously apply knowledge in academic and professional activities, and the development of critical thinking and confidence in forming personal viewpoints. *Recommended Practical Topics:* 1. Prepare a table of selection criteria for innovative road construction materials under specified climatic conditions and traffic loading. 2. Calculate a blend of two or three aggregate fractions to meet the specified grading requirements. 3. Calculate binder component quantities from the mass fraction of polymer or rubber modifier and develop a production scheme. 4. Compare binder options for specified service conditions using bitumen test results and rheological data. 5. Calculate asphalt concrete volumetric properties and select an option using balanced mix design criteria. 6. Calculate component quantities for stone mastic or fiber-reinforced asphalt concrete and define the production sequence. 7. Compare the energy consumption of warm-mix and conventional hot-mix asphalt technologies using the supplied production data. 8. Calculate the mass balance of a mixture of RAP and virgin materials, and justify the choice of rejuvenator. 9. Develop a cold recycling mix design and process flow diagram using bitumen emulsion or foamed bitumen. 10. Calculate alternative pavement cement concrete mixes with mineral additions and select one using the supplied test results. 11. Calculate binder quantities for soil stabilization and prepare a quality control plan based on replicate tests. 12. Compare two alternative material technologies by life-cycle costs and carbon emissions, and justify the final solution. **IV. Independent learning and independent work** Independent learning competency helps students to develop self-improvement skills and increase the efficiency of their professional activities. Students perform independent tasks on their mobile devices under the guidance of a teacher, either in traditional or electronic form. Recommended topics for independent work: 1. Prepare a table of technical specifications for local road construction materials and innovative alternatives.

	2. Write a short comparative review of at least three scholarly sources on polymer- and rubber-modified bitumens. 3. Prepare a research plan on bitumen ageing and rejuvenation, specifying experimental factors, a control specimen and replicate tests. 4. Develop and defend a group project on balanced mix design for asphalt concrete using local raw materials. 5. Prepare a presentation comparing the application conditions of stone mastic, high-modulus and porous asphalt. 6. Compare warm-mix asphalt production methods by energy consumption, equipment and quality requirements. 7. As a group, develop a material balance, production scheme and quality control plan for a RAP-containing mixture. 8. Analyze bitumen emulsion and foamed bitumen options for cold recycling and prepare a method statement. 9. As a group, develop a cement concrete mix with mineral additions or recycled aggregates and justify a test program. 10. Solve an engineering case involving soil stabilization, industrial by-products or geosynthetics. 11. Review a research paper on self-healing, bio-based or sensor-equipped road materials and describe their potential and limitations. 12. As a group, compare two technologies using LCA and LCCA, perform sensitivity analysis and defend an implementation proposal.
Exam form	Written
Teaching/learning and examination requirements	Complete mastery of theoretical and methodological concepts and practical knowledge of the discipline, the ability to correctly reflect the results of analysis, independently reason about the processes being studied and carry out tasks in the current, intermediate forms of control and independent work, pass written work on the final control. When drawing up final exam questions, deviations from the content of the discipline program are not allowed. The bank of final exam questions for each discipline is discussed at the meeting and approved by the head of the department. No later than 1 week before the start of the final control, tickets signed by the head of the department, enclosed in an envelope, are sealed by the Dean’s office and opened 5 minutes before the start of the exam in the presence of students. Final exam duration is 80 minutes. Answers to final exam questions are recorded in copybooks with the seal of the Dean’s office. After completion of the final work, the work is immediately encrypted by a representative of the Dean’s office, and the copybooks are handed over to the commission for verification. From the moment of completion of the final exam, a period of 72 hours is allotted for checking and posting the results on the electronic platform. The teacher who taught the students in this discipline is not involved in the process of conducting the exam and checking the students' answers. Student(s) who are dissatisfied with the final exam results may submit a written or oral appeal within 24 hours of the publication of the final exam results. Complaints submitted after 24 hours from the publication of the final exam results will not be accepted.
Scope of assessment criteria and procedure	CURRENT CONTROL Purpose: Determining and assessing the student's level of knowledge, practical skills, and competencies on course topics. Instructions: The student's activity in daily classes is assessed through the student's mastery of course topics, as well as constructively interpreting and analyzing the educational material, developing module specific skills, acquiring practical skills (in terms of quality and the specified number) and

	competencies, solving problem situations aimed at applying professional practical skills, working in a team, preparing presentations, etc. Current control form: Activity in lessons; Preparing educational materials; Working with sources within the subject; Using educational technologies; Working in a team Preparing presentations; Working with projects. MIDTERM CONTROL Purpose: Assessing the student's knowledge and practical skills and level of mastery of lecture material after completing the relevant section of the course. Form and procedure of intermediate control: Midterm examination is held during the semester during the training sessions after the completion of the relevant module of the curriculum of the subject. Midterm examination is held once in written form within the framework of this subject. Midterm examination questions cover all topics of the subject. INDEPENDENT LEARNING Purpose: Independent learning is aimed at fully covering the content of this course, expanding the theoretical knowledge acquired, and establishing independent learning activities for students. Form and procedure of independent education: independent work assignments are completed in the form of an educational project, presentation, case study, problem solving, information search, digest, colloquium, essay, article, abstract, etc. Completed assignments for independent study are placed in the electronic system and checked based on the anti-plagiarism program and evaluated by the subject teacher. In this case, the uniqueness of the completed assignment should not be less than 60%, otherwise the assignment will not be accepted for assessment. The number of independent work assignments, depending on the nature of the subject, should not be less than 3 for one subject (module). Independent work assignments account for 60% of the points allocated for current and intermediate control. FINAL CONTROL Purpose: The final examination is held at the end of the semester to determine the level of mastery of the student's theoretical knowledge and practical skills in the relevant subject. The final examination is held at a specified time according to the examination schedule created by the Registrar's Office on the electronic platform. Requirements: The student must have passed the current control, intermediate control and independent learning assignments by the deadline for the final control type in the relevant subject. A student who has not passed the current control, intermediate control and independent learning assignments, as well as who has received a score in the range of “0-29,9” for these assignments and control types, is not included in the final control type. Also, a student who has missed 25 percent or more of the classroom hours allocated to a subject without a reason is excluded from this subject and is not included in the final control type and is considered not to have mastered the relevant credits in this subject. A student who has not passed or was not included in the final control type and has received a score in the range of “0-29.9” for this type of control is considered to be an academic debtor. Final control form: The final examination in this subject will be conducted in written form. If the final examination is conducted in written form, the requirements for assessment must also be reflected.
Criteria for assessing student knowledge	**5 grade** | **100 points** | | **Assessment criteria**

	5	90-10	Excellent	When a student is considered to be able to make independent conclusions and decisions, think creatively, observe independently, apply the knowledge he has gained in practice, understand, know, express, and narrate the essence of the subject, and have an idea about the subject.
	4	70-89,9	Good	When the student is considered to be able to observe independently, apply the knowledge he has gained in practice, understand, know, express, and narrate the essence of the subject, and has an idea about the subject
	3	60-69,9	Satisfactory	When the student is found to be able to apply the knowledge he has gained in practice, understands, knows, can express, and narrate the essence of the subject, and has an idea about the subject.
	2	0-59,9	Unsatisfactory	When it is determined that the student has not mastered the science program, does not understand the essence of the subject, and does not have an idea about the science.

Course assessment criteria and procedure	**Assessment type**	**Total points allocated**	**Control (task) form**	**Distribution of points**	**Qualifying score**
	Current assessment	30 points	System tasks	20 points (divided by number of tasks)	18 points
			Student activity (in seminars, practical, laboratory classes)	10 points	

<table>
<tr><td></td><td>
<table>
<tr><td rowspan="2">Midterm assessment</td><td rowspan="2">20 points</td><td>Supervision: writing work</td><td>10 points</td><td rowspan="2">12 points</td></tr>
<tr><td>System tasks</td><td>10 points (divided by number of tasks)</td></tr>
<tr><td>Final assessment</td><td>50 points</td><td>Written assignment (5 questions)</td><td>50 points (10 points per question)</td><td>30 points</td></tr>
</table>

* Note: 60% of the points allocated for current and intermediate control are allocated to independent work assignments. Independent work assignments are evaluated as system assignments through the electronic platform.
</td></tr>
<tr><td>Recommended Literature</td><td>1. Mallick R. B., El-Korchi T. Pavement Engineering: Principles and Practice. 4th ed. Boca Raton: CRC Press, 2023. 818 p.
2. Hettiarachchi C., Mampearachchi W. Handbook of Asphalt Technology. Singapore: Springer, 2025. XXIV, 277 p.
3. Tabakovic A., Valentin J., He L. (eds.). Advances in Asphalt Pavement Technologies and Practices. Basel: MDPI, 2022. 322 p.
4. Chung H.-W., DeFord H., Tia M., Ni F. M.-W. Developing Sustainable Pavement Concrete Mix Using Portland Limestone Cement and Blended Aggregates Techniques // Transportation Research Record. 2023. Vol. 2677, no. 7.
5. Federal Highway Administration. 2023 North Central Peer Exchange on Balanced Mix Design (BMD): Outcomes and Summary. Report FHWA-HIF-23-032. 2023.</td></tr>
</table>