Name of subject	ROAD-SECTOR TELEMATICS (ECTS 6)
Subject/module code	**YST1206**
Science taught semester (s).	2nd semester
Responsible teacher	Ganiyev Inomjon Gulomovich – head of the department "Road engineering", PhD, professor
Education language	Uzbek
Connection to the curriculum	Compulsory
Training hours (this including independent education)	**Total hours – 180 hours** **Contact hours – 54 hours** Lecture training hours – 24 hours Practical training hours – 30 hours **Independent education – 126 hours**
Course work	No
ECTS	6
The purpose and tasks of subject / learning outcomes	**The purpose of teaching the subject is** To develop competence in road telematics and intelligent transport systems for roads, motorways and airport landside transport, including sensor networks, GNSS, communications, data engineering, real-time analytics, adaptive control, V2X, cybersecurity and digital-twin technologies. **The objectives of teaching the subject** are to define ITS services, stakeholders, use cases, and requirements based on ISO 14813 and contemporary reference architectures; collect and quality-check data from inductive loop detectors, radar, LiDAR, video cameras, weigh-in-motion (WIM) systems, road weather information systems (RWIS), Bluetooth/Wi-Fi technologies, and probe vehicles; apply GNSS/GIS, map matching, and geofencing; evaluate fiber-optic, 4G/5G, Wi-Fi, LPWAN, C-V2X, and ITS-G5 communication options; develop edge/cloud computing solutions, APIs, stream-processing pipelines, databases, and dashboards; model algorithms for traffic state estimation, forecasting, incident detection, adaptive traffic signal control, ramp metering, variable message signs (VMS), and routing; analyze airport landside traffic flows, terminal curbside operations, parking, and service vehicle monitoring; become familiar with surveillance and warning systems for aerodrome movement areas; analyze V2I/V2V message exchange, eCall, and safety applications; and develop an understanding of cybersecurity, privacy, interoperability, key performance indicators (KPIs), cost–benefit analysis, and life-cycle requirements through an integrated project. **Learning outcomes:** 1. Systematically formulate ITS/road-telematics services, stakeholders, use cases, operational concepts, functional/physical/communication architectures and interoperability requirements. 2. Evaluate operating principles, accuracy, coverage, latency, failure modes and calibration requirements of inductive sensors, radar, lidar, video, WIM, RWIS, Bluetooth/Wi-Fi and probe-vehicle sources. 3. Analyze GNSS/GIS, map matching, geofencing, time synchronization, coordinate/map quality and compare fiber, 4G/5G, Wi-Fi, LPWAN, C-V2X and ITS-G5 communication options. 4. Design edge/cloud architecture, APIs, message brokers, stream processing, databases, metadata, data-quality, audit-trail and dashboard layers.

	5. Explain traffic-state estimation, queues/travel time, incident detection, forecasting, adaptive control, VMS, ramp metering and routing, including airport landside/service-vehicle flow management. 6. Clean, merge, statistically analyze and visualize sensor and trajectory data using Python or MATLAB. 7. Model and calibrate a road network, detectors, signals and control scenarios in VISSIM, Aimsun, SUMO or equivalent and compare before/after results. 8. Conceptually develop C-ITS/V2X use cases, V2I/V2V information flows, message types, roadside/on-board units and safety performance. 9. Specify cybersecurity, privacy, access control, network segmentation, backup, continuity, fail-safe and incident-response measures for a telematics system. 10. Develop and defend a data-driven telematics solution for a road/motorway corridor or airport landside system including architecture, sensors, communications, software, KPIs, cost-benefit, risk and implementation stages.
Course content (topics)	**I. Main Theoretical Part (Lecture Sessions).** Topics: 1. Introduction to road telematics and ITS 2. Traffic and infrastructure monitoring sensors 3. GNSS, GIS and movement trajectories 4. Communication technologies in transport telematics 5. Transport data engineering 6. Traffic-state estimation and incident detection 7. Automated traffic management 8. Cooperative ITS and V2X 9. Road and aerodrome transport-safety telematics 10. Transport data analytics and artificial intelligence 11. Cybersecurity, privacy and interoperability 12. Digital twins and telematics-system deployment **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. Develop ITS problem, stakeholders, use case, concept of operations and architecture 2. Process sensor data in Python/MATLAB and prepare data-quality report 3. Process GNSS trajectories, map matching, travel time and heat maps 4. Prototype edge/API/database/dashboard data flow

	5. Estimate traffic state and short-term forecast from detector/probe data 6. Build and calibrate corridor/intersection model in VISSIM/Aimsun/SUMO 7. Develop TMC/Airport Operations Center incident workflow and KPI dashboard 8. Develop V2X signalized-intersection use case and information flow 9. Develop telematics cybersecurity threat model and response plan 10. Prepare integrated telematics project and professional presentation **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. Analytical bibliography on road telematics and ITS 2. Sensor layout, sampling, calibration, redundancy and data-quality plan 3. GNSS/probe trajectory analysis and travel-time reliability 4. Compare fiber, 4G/5G, LPWAN, C-V2X and ITS-G5 5. Prototype sensor-edge-cloud data pipeline and dashboard 6. Model adaptive-signal/corridor-control scenarios 7. V2X or airport-transport safety use case 8. Cybersecurity, privacy, continuity and incident-response plan 9. Integrated telematics architecture, KPI, risk, cost-benefit and implementation roadmap
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.

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<tr><td></td><td colspan="5">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.</td></tr>
<tr><td>Criteria for assessing student knowledge</td><td colspan="5"><table>
<tr><th>5 grade</th><th>100 points</th><th></th><th>Assessment criteria</th></tr>
<tr><td>5</td><td>90-10</td><td>Excellent</td><td>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.</td></tr>
<tr><td>4</td><td>70-89,9</td><td>Good</td><td>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</td></tr>
<tr><td>3</td><td>60-69,9</td><td>Satisfactory</td><td>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.</td></tr>
<tr><td>2</td><td>0-59,9</td><td>Unsatisfactory</td><td>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.</td></tr>
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<tr><td>Course assessment criteria and procedure</td><td colspan="5"><table>
<tr><th>Assessment type</th><th>Total points allocated</th><th>Control (task) form</th><th>Distribution of points</th><th>Qualifying score</th></tr>
<tr><td rowspan="2">Current assessment</td><td rowspan="2">30 points</td><td>System tasks</td><td>20 points (divided by number of tasks)</td><td rowspan="2">18 points</td></tr>
<tr><td>Student activity (in seminars,</td><td>10 points</td></tr>
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<tr><td></td><td></td><td>practical, laboratory classes)</td><td></td><td></td></tr>
<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.
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<tr><td>Recommended Literature</td><td>
1. Ganiyev, I. Yo‘l sohasi telematikasi / I. Ganiyev. — Jizzakh: So‘g‘diyona NMU, 2024. 198 b.
2. Intelligent Road Transport Systems: An Introduction to Key Technologies / ed. by Y. Wang, X. Yan, G. Lu, C. Wu. — Singapore: Springer, 2022. — VIII, 608 p.
3. ISO 14813-1:2024. Intelligent transport systems — Reference model architecture(s) for the ITS sector — Part 1: ITS service domains, service groups and services. — 3rd ed. — ISO, 2024. — 121 p.
4. ISO 21217:2020. Intelligent transport systems — Station and communication architecture. — 3rd ed. — ISO, 2020. — 55 p.
5. ITU. Land Mobile (including Wireless Access). Volume 4: Intelligent Transport Systems. — 2021 ed. — Geneva: ITU, 2021. — 103 p.
6. ITS ePrimer. Module 1: Introduction to ITS [Elektron resurs] / P. Noye; U.S. Department of Transportation. — 2021 update. — 19 p. — URL: https://www.its.dot.gov/pcb/eprimer/documents/module1.pdf
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