Name of subject	HIGHWAY OPERATIONS (14 ECTS)
Subject/module code	**AYEQ16714**
Science taught semester (s).	6th and 7th semesters
Module leader	D. G‘ulomov, PhD, Acting Associate Professor, Department of Road Engineering
Education language	Uzbek
Connection to the curriculum	Compulsory
Training hours (this including independent education)	**Total hours – 420 hours** **Contact hours – 168 hours** Lecture training hours – 72 hours Practical training hours – 72 hours Laboratory classes – 24 hours **Independent study – 252 hours**
Course work	No
ECTS	14
The purpose and tasks of subject / learning outcomes	**The purpose of teaching the subject is** to use evidence to assess the condition and performance of a highway, select maintenance and repair measures for safe, uninterrupted use, plan resources and timing, and check the results of the work. **The objectives of teaching the subject** are to study how loading and climate affect road assets. Collect and check inspection data, and assess roughness, rutting, skid resistance, distress and structural capacity separately. Plan summer, winter and emergency services. Integrate roadbeds, drainage, road equipment and structures into a maintenance programme, using risk, budget, life-cycle costs and digital asset records to justify decisions. **Learning outcomes:** 1. Explain highway operations, road assets, service outcomes and the applicable classification of maintenance and repair work. 2. Use patrol and periodic inspection records to prepare a defect register showing type, location, quantity and any further measurements required. 3. Distinguish and interpret indicators of roughness, rutting, texture, skid resistance and structural capacity. 4. Check the source, units, repeatability, seasonal conditions and calibration of measurements, and report uncertainty. 5. Create digital asset records and a GIS table with unique identifiers linking road segments and assets to condition and work history. 6. Justify maintenance or more extensive repair using condition, risk, the importance of the road for traffic, drainage conditions and budget limits. 7. Plan observations, actions, resources and the sequence of response for summer, winter and emergency operations. 8. Integrate the condition of the roadbed, shoulders, drainage, bridges, culverts and road equipment into a highway operations programme. 9. Analyse traffic and crash records in relation to exposure and site conditions, and justify measures for work-zone and road-user safety. 10. Compare quantities, crew and equipment needs, schedules, costs and life-cycle alternatives using calculations that can be checked. 11. Check condition forecasts, monitoring data and completed services against the specified criteria. Record limitations and corrective actions. 12. Defend an individual semester 7 coursework proposal that brings together diagnostics, annual maintenance, resources, costs and monitoring.

Course content (topics)	**I. Main Theoretical Part (Lecture Sessions).** Topics: 1. Highway operations and management. 2. Service outcomes and regulatory requirements. 3. Road asset inventories. 4. Traffic and loading. 5. Pavement deterioration. 6. Roadbed, moisture and climate. 7. Pavement distress. 8. Roughness, rutting, texture and skid resistance. 9. Structural capacity and diagnostic evidence. 10. Patrols and periodic inspections. 11. Road geometry and operating conditions. 12. Databases and geographic information systems (GIS). 13. Condition indices and data quality. 14. Risk and work priorities. 15. Preliminary annual maintenance programme. 16. Preventive and corrective strategies. 17. Crack and pothole treatments. 18. Surface treatment and functional restoration. 19. Strengthening and reconstruction needs. 20. Shoulders, roadsides and vegetation. 21. Drainage and water crossings. 22. Winter operations. 23. Summer and seasonal operations. 24. Emergency operations. 25. Bridges and culverts in the maintenance programme. 26. Road equipment and facilities. 27. Work zones and traffic continuity. 28. Road safety data. 29. Deterioration models. 30. Life-cycle costs. 31. Equipment, crews and productivity. 32. Multi-year programmes and budgets. 33. Quality control and acceptance. 34. Performance-based service requirements. 35. Environmental effects and waste. 36. Digital management and final reporting. **II. Instructions and recommendations for organizing laboratory exercises** Reports identify the method, equipment or data source, raw records, units, calculations, quality checks and conclusion. Take measurements under supervision at the training site or in the laboratory. When specialist equipment is needed, identify partner-laboratory results or supplied observations separately from your own measurements. Photographs document appearance. Retroreflectivity requires an instrument, and an estimate of service life requires evidence beyond density. Topics: 1. Identify instruments for road condition surveys. Log instruments, units, calibration, observation conditions and raw data. 2. Evaluate traffic capacity from class observations or supplied flow data. Tabulate the calculation, conditions and limitations. 3. Identify defects in digital photographs or video. Map type, location and image ID. Quantify dimensions where a verified scale is available.

	4. Assess pavement structural condition from a supplied deflection series or other test data. Document environmental and modelling assumptions. 5. Check pavement skid resistance. Compare the measured result with the given criterion, recording method, surface condition and instrument. 6. Assess a prepared pavement sample. Measure mass and volume, calculate density and document limitations of the method 7. Measure traffic volume. Record counting intervals, directions, vehicle types and counts, noting uncertainty associated with the observation period. 8. Compare road geometry and observed traffic speeds for the conditions represented in the supplied datasets. 9. Inspect road signs and markings. Map location, condition, evidence of visibility or measured retroreflectivity, and service needs. 10. Evaluate road lighting performance from class measurements or supplied illuminance, power and operating-time data. 11. Verify drone, IoT or computer vision results on a supplied dataset. Record detection errors, agreement with checks, source and human review. 12. Combine validated diagnostic records in a condition assessment. Calculate the index by the specified method and recommend a service response. **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. Define operational tasks and service outcomes. Tabulate road segments, user needs and measurable indicators. 2. Classify example works under the applicable scheme. Justify the category for inspection, maintenance, defect treatment and repair cases. 3. Prepare an asset register with segments, coordinates, elements, identifiers and data sources. 4. Analyse traffic flows and loads in a worksheet showing observation periods, vehicle mix and variation. 5. Draw a cause-and-evidence diagram linking deterioration to loading, materials, water and temperature, with data needed to test each hypothesis. 6. Assess seasonal moisture and temperature in the roadbed. Map high-risk periods, water sources and observation points. 7. Map pavement distress and prepare a register showing type, location, severity and measured extent. 8. Compare roughness, rutting and skid resistance. Give separate units and conclusions for IRI, straightedge deviation, rut depth, texture and friction. 9. Interpret FWD, GPR and sample evidence. Record pavement layers, environmental conditions, calibration, model assumptions and further investigation needs.

	10. Plan patrols and periodic inspections. Specify routes, timing, record forms, notifications and response steps. 11. Map geometric constraints and operating conditions, including width, gradient, sight distance and observed speeds. 12. Build a GIS condition layer and digital record linking segment identifiers, defects, dates and work history. 13. Calculate a condition index using the given method. Show units, normalisation, weights and the observations behind the result. 14. Assess risk and rank work by safety, water, traffic importance and condition. Compare how the rankings change with the weights. 15. Prepare a preliminary annual maintenance table by segment, with the work, its justification, timing, resources and service outcome. 16. Compare preventive and corrective strategies in a matrix covering suitability, timing, expected results and monitoring evidence. 17. Recommend treatment for a crack or pothole using its cause, severity and work quantity. Specify the follow-up check. 18. Justify a functional restoration treatment. Prepare a check sheet covering surface condition, texture, water and treatment performance. 19. Assess the need for strengthening or reconstruction. Document functional and structural evidence, missing information and design requirements. 20. Prepare a shoulder and roadside work register covering erosion, waste, vegetation and visibility. 21. Assess drainage and culverts. Map blockages, ponding and outlets, and prioritise work before flooding. 22. Develop a winter service scenario covering weather observations, routes, equipment, materials and required service outcomes. 23. Prepare a seasonal work calendar for heat, dust, sand, rainfall and water conditions. 24. Prepare an emergency response plan showing notification, hazard containment, responsibilities, inspection and recovery. 25. Integrate bridges and culverts into the road programme. Specify maintenance and specialist inspections for decks, joints, approaches and water flow. 26. Assess signs, markings, barriers and lighting. Map asset identifiers, inspection or measurement evidence and renewal needs. 27. Check each work-zone stage against the traffic layout. Record work areas, access, warnings and control measures. 28. Compare crash and traffic data. Report exposure, reporting quality, site conditions and the limits of causal interpretation. 29. Assess a deterioration trend. Plot the observations, fitted model, calibration range and forecast uncertainty. 30. Calculate life-cycle costs for two strategies using a common analysis period. Tabulate discounting, intervention timing, cost perspective and sensitivity. 31. Calculate crew and equipment needs. Plan quantities, routes, shifts, productivity and material supply. 32. Develop multi-year alternatives under a limited budget. Show segments, intervention years, costs and consequences of deferral. 33. Verify completed maintenance. Record location, quantity, measurements, acceptance criteria and evidence of corrections. 34. Develop performance-based service indicators. Tabulate measurable outcomes, response times, monitoring and supporting documents.

	35. Compare environmental and resource alternatives. Quantify water, dust, winter materials, energy and waste, and plan the checks. 36. Defend an operations and monitoring proposal. Submit diagnostics, alternatives, work plan, costs, digital asset record and verification files. **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 operational tasks, applicable work categories and service outcomes for a road section. 2. Compile a road asset inventory. Verify segments, elements, identifiers and sources. 3. Use evidence to analyse how traffic, loading and seasonal environmental conditions affect road condition. 4. Prepare a defect register and a diagram linking possible causes to evidence. Identify measured quantities and further measurements needed. 5. Check roughness, rutting, skid resistance and structural condition data separately. 6. Plan patrols, periodic inspections and risk response. Justify the route and the form used to collect evidence. 7. Create a digital asset record and a GIS segment table. Verify coordinates, dates and work histories. 8. Calculate priorities from condition and risk. Compare the sensitivity of rankings to weights and uncertainty. 9. Organise, verify and defend the semester 6 portfolio on diagnostics and preliminary maintenance planning. 10. Compare preventive treatment, functional restoration and strengthening against condition and applicability. 11. Integrate shoulder, drainage, bridge and culvert maintenance into a common road programme. 12. Map service needs and quality evidence from the condition of signs, markings, barriers and lighting. 13. Use crash, exposure and work-zone data to analyse safety and specify follow-up checks. 14. Compare winter and seasonal service scenarios by materials, routes, equipment and environmental outcome. 15. Prepare a simple condition forecast and calculate life-cycle costs for two strategies. Report assumptions and sensitivity. 16. Reconcile the service programme with crew, equipment, schedule and budget constraints. 17. Verify acceptance and monitoring evidence for completed work. Record nonconformities and plan corrections. 18. Examine the article's condition indicators, weighting and prioritisation method. Check the numerical result for the class example. 19. Prepare the coursework brief and source data register. Analyse diagnostic evidence, likely defect causes and work priorities. 20. Calculate treatment quantities, resources and costs for the coursework, and compare two strategies over their life cycles. 21. Allow 6 hours for the coursework schedule, quality checks, monitoring, A1 drawing sheet and defence, and 6 hours for checking the complete portfolio.
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

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<tr><td></td><td>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.</td></tr>
<tr><td>Criteria for assessing student knowledge</td><td>
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<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>
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	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	
Midterm assessment	20 points	Supervision: writing work	10 points	12 points
		System tasks	10 points (divided by number of tasks)	
Final assessment	50 points	Written assignment (5 questions)	50 points (10 points per question)	30 points

* 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.

Recommended Literature

1. Cabinet of Ministers of the Republic of Uzbekistan. Resolution No. 901 of 30 December 2024, Annex 2. Classification of highway repair and maintenance works. Version of 25 August 2026 cited in the syllabus. lex.uz
2. Smith, K., Grogg, M., Ram, P., Smith, K., Harrington, D. Concrete Pavement Preservation Guide. 3rd ed. National Concrete Pavement Technology Center, Iowa State University, August 2022. www.cptechcenter.org
3. Chang, G. K., Gilliland, A. L., TaghaviGhalesari, A., Rada, G. R., Serigos, P. A., Simpson, A. L., Kouchaki, S. Successful Practices for Quality

	Management of Pavement Surface Condition Data Collection and Analysis: Final Report. FHWA, February 2023. FHWA-RC-23-0002. www.fhwa.dot.gov 4. Schaefer, K., Carlson, M., Johnson, C. Minnesota Snow and Ice Control Handbook for Snowplow Operators. MnLTAP, University of Minnesota, January 2022. Report 2022RIC01. rosap.ntl.bts.gov 5. Rogers, M., Enright, B. Highway Engineering. 4th ed. John Wiley & Sons, 2023. ISBN 9781119883302. www.wiley-vch.de 6. Republic of Uzbekistan. Law on Highways, No. O‘RQ-1162 of 5 August 2026. Provisions on operations and maintenance cited in the syllabus. lex.uz 7. Huang, L.-L., Lin, J.-D., Huang, W.-H., Kuo, C.-H., Chiou, Y.-S., Huang, M.-Y. Developing Pavement Maintenance Strategies and Implementing Management Systems. Infrastructures, 9(7), 2024, 101. DOI 10.3390/infrastructures9070101. www.mdpi.com 8. UNSW Canberra. ZEIT3606 — Pavement and Foundation Engineering. Semester 2, 2021. Course outline. www.coursearchive.unsw.edu.au 9. UNSW Sydney. Official announcement of the QS World University Rankings 2027 results. June 2026. Rank reported in the syllabus: 19th. www.unsw.edu.au 10. Papagiannakis, A. T., Masad, E. A. Pavement Design and Materials. 2nd ed. John Wiley & Sons, 2024. ISBN 9781394150175. www.wiley-vch.de