Name of subject	HIGHWAY ROUTE SURVEYS AND INVESTIGATIONS (8 ECTS)
Subject/module code	**YQDM13408**
Science taught semester (s).	3rd and 4th semesters
Module leader	Professor Inomjon G‘aniyev, Candidate of Technical Sciences, Head of the Department of Road Engineering
Education language	Uzbek
Connection to the curriculum	Compulsory
Training hours (this including independent education)	**Total hours – 240 hours** **Contact hours – 96 hours** Lecture training hours – 24 hours Practical training hours – 48 hours Laboratory classes – 24 hours **Independent study – 84 hours**
Course work	No
ECTS	8
The purpose and tasks of subject / learning outcomes	**The purpose of teaching the subject is** teaching to learn to acquire, verify and synthesise the topographic, geodetic, engineering-geological and hydrometeorological data needed to design, build and reconstruct roads. By the end of the module, they can plan a route investigation, process observations and prepare a technical report that supports their conclusions. **The objectives of teaching the subject** are to understand the stages of a route investigation and interpret its terms of reference. Analyse maps, coordinates and elevations. Use survey instruments and check measurements. Organise evidence on soils, groundwater and watercourses. Investigate alternative alignments, longitudinal profiles, cross-sections and sites for highway structures. Validate a digital terrain model and judge the accuracy, completeness and limitations of the survey results. **Learning outcomes:** 1. Explain the purpose and stages of a route investigation, identify the initial data required and relate the scope of work to the terms of reference. 2. Interpret topographic maps and horizontal and vertical reference systems. Assess the accuracy and currency of the data. 3. Explain how geodetic, geological and hydrometeorological observations inform road engineering decisions. 4. Identify sources of measurement error and justify the choice of check observations and processing methods. 5. Take measurements in a training exercise using a level, theodolite or total station and keep a systematic field book. 6. Check traverse and levelling results, calculate coordinates and elevations and compile a record of the checks. 7. Use survey data to produce a topographic plan, longitudinal and cross-sectional profiles and a digital terrain model. 8. Organise data on soils, groundwater, river channels and catchments and identify where further investigation is needed. 9. Prepare an investigation plan for alternative route corridors and difficult sites. Compare the alternatives using the available evidence. 10. Present investigation results in digital files, drawings and a technical report. Defend the conclusions and explain their limitations.
Course content (topics)	**I. Main Theoretical Part (Lecture Sessions).** Topics: 1. Purpose and stages of a route investigation. 2. Topographic maps and horizontal and vertical reference systems.

	3. Survey control and instruments. 4. Digital survey data. 5. Engineering-geological investigations. 6. Hydrometeorological investigations. 7. Desk studies and reconnaissance. 8. Horizontal alignment surveys. 9. Surveying for longitudinal profiles and cross-sections. 10. Highway structures and difficult sites. 11. Surveys for road reconstruction. 12. Survey management and technical reporting. **II. Instructions and recommendations for organizing laboratory exercises** Each laboratory report states the aim, describes the instrument or data, records the original observations and calculations, documents an independent check and draws a conclusion. Field measurements take place on the training ground under the instructor's supervision. If specialist instruments are unavailable, students may use a partner organisation's facilities or previously collected field observations. Each report identifies the method used. Geological and hydrological work focuses on collecting and interpreting evidence; it requires neither deep drilling nor independent measurements in a hazardous river channel. Topics: 1. Inspect, centre and level a survey instrument. Complete the instrument data sheet, record the checks and document the setup sequence. 2. Measure horizontal and vertical angles. Record repeat observations, differences and the final angles in a field book. 3. Measure distances electronically. Tabulate the distances and observation conditions and analyse a check measurement. 4. Run a closed levelling loop. Record staff readings, elevation differences and vertical misclosure. 5. Verify control points using GNSS. Record observation metadata, differences from known coordinates and a conclusion. 6. Carry out a total station survey. Code the points and submit their coordinates and a topographic plan of the training site 7. Set out a circular curve on the training ground. Mark the points and record the results of an independent check. 8. Level along an alignment. Record chainage points and intermediate points and calculate elevations for the longitudinal profile. 9. Survey the points of a cross-section. Record offsets and elevations and draw the section. 10. Describe and log a soil sample in the field. Enter the sample identifier, depth and condition in the investigation log. 11. Measure a river channel cross-section or a section of a teaching model. Draw the section and record the water level and observation date. 12. Check UAV survey and DEM results against independent checkpoints. Calculate horizontal and vertical differences and report on data quality. **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. Interpret topographic map scales and symbols. Submit a map showing route corridor features and a data sheet describing the source. 2. Compare coordinate and elevation systems. Tabulate units, control points and the conditions for converting between systems. 3. Measure distances and areas on a map and derive a terrain profile. Submit calculations with units and a drawing. 4. Analyse errors affecting angle, distance and elevation measurements. Tabulate the corrections and checks 5. Compute a theodolite traverse. Submit the coordinate schedule with checks on angular and coordinate misclosure. 6. Adjust a levelling run. Tabulate the vertical misclosure, corrections and adjusted elevations. 7. Verify GNSS results. Record observation conditions, the horizontal and vertical reference systems and differences at control points. 8. Build a terrain model and define breaklines from surveyed points. Submit a DEM/TIN and describe its input data. 9. Delineate slopes, drainage divides and catchments. Produce a map and comment on the accuracy of the terrain model. 10. Construct an engineering-geological section from borehole logs. Show strata, sampling locations and groundwater levels. 11. Plan an investigation of soils and groundwater. Identify observation points, the data needed and the reasons for the proposed work. 12. Organise baseline hydrometeorological data. Tabulate sources, observation periods and gaps. 13. Compare two route corridors. Present evidence on terrain, ground conditions, water and land-use constraints in a comparison table. 14. Plan a reconnaissance route and fieldwork. Submit the itinerary, a list of features to inspect and a field record form. 15. Calculate chainage-point coordinates and alignment bearings. Prepare a chainage and setting-out schedule. 16. Calculate setting-out data for a circular curve. List the curve elements, point locations and check calculations. 17. Prepare survey and setting-out data for a transition curve. Submit a working schedule and a checking diagram. 18. Plot a longitudinal profile of the route. Verify the chainages, distances and elevations shown. 19. Draw cross-sections. Submit drawings and a schedule of section points, offsets and elevations. 20. Plan an investigation for a bridge or culvert site. Show how to collect evidence on channel geometry, scour, water levels and ground conditions. 21. Inventory the features of an existing road. Record geometry, structures, drainage and the date of inspection. 22. Map utilities and environmental constraints. Create map layers that identify data sources and verification status. 23. Check the accuracy and completeness of field data. Record errors, corrections and the acceptance check. 24. Compile a topographic plan and technical report. Present the digital model, drawings and supporting evidence and defend the conclusion.

	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. Draft the terms of reference for the survey of a selected road section and list the expected deliverables. 2. Draw the horizontal and vertical control network and assess the information available for existing control points. 3. Collect topographic maps, imagery and archive records as a group. Compile a source register. 4. Analyse GNSS observation metadata and check differences, and document the limits of accuracy. 5. Georeference a map. Document the control points and the result of the transformation. 6. Use checkpoints to compare two terrain models as a group. Defend the explanation for the observed differences. 7. Prepare a training map and a cross-section from soil-strata and groundwater data. 8. Analyse the baseline data needed for a catchment and a watercourse crossing. 9. Review the semester 3 survey portfolio as a group. Record errors and missing information. 10. Compare two alternative corridors using available survey evidence and justify the additional checks required. 11. Prepare a curve setting-out schedule and an independent checking diagram. 12. Design a measurement programme for longitudinal profiles and cross-sections as a group. Cross-check the records. 13. Develop a programme of topographic, geological and hydrological investigations for a bridge or culvert crossing. 14. Prepare a survey and inventory programme for the reconstruction of an existing road. 15. Prepare a group map of utilities, environmental constraints and engineering hazards. 16. Create a time, equipment and resource plan for a field crew. Justify the sequence of operations. 17. Compile an integrated digital survey model. Apply an accuracy check from a recent research paper to the model. 18. Prepare a final technical survey report as a team. Each member defends their own contribution.
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

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<tr><td></td><td>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>
<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</td></tr>
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<tr><td></td><td></td><td></td><td>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, practical, laboratory classes)</td><td>10 points</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.</td></tr>
<tr><td>Recommended Literature</td><td colspan="5">1. Ghilani, C. D. Elementary Surveying: An Introduction to Geomatics. 16th ed. Pearson, 2022. ISBN 9780136822806.
2. Ogaja, C., Adero, N., Koome, D. Project Design for Geomatics Engineers and Surveyors. 2nd ed. CRC Press, 2023. DOI 10.1201/9781003297147.
3. California Department of Transportation. Geotechnical Investigations. Geotechnical Manual module. November 2023. 9 p.
4. Kilgore, R., Atayee, A. T., Herrmann, G. R., Thompson, D. B. Highway Hydrology. 3rd ed. FHWA, March 2024. Hydraulic Design Series 2. FHWA-HIF-24-007.
5. U.S. Geological Survey. Lidar Base Specification. 2025 rev. A. June 2025.
Additional reading
6. Li, Q. Dynamic and Precise Engineering Surveying. Springer Singapore, 2023. DOI 10.1007/978-981-99-5942-6.
7. UNSW Sydney. GMAT2120 Surveying and Geospatial Technology. Term 3, 2022. Course Profile.
8. UNSW Sydney. UNSW claims Australia’s top spot for the first time in preeminent world university rankings. 2026.
9. Malić, B., Moser, V., Rajle, D., Kulić, S., Barišić, I. Comparative Assessment of Vertical Precision of Unmanned Aerial Vehicle-Based Geodetic Survey for Road Construction: A Multi-Platform and Multi-Software Approach. Infrastructures, 2025, 10(11), 287.</td></tr>
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