Name of subject	HIGHWAY STRUCTURES (8 ECTS)
Subject/module code	**AYSI1508**
Science taught semester (s).	5th semester
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 – 240 hours** **Contact hours – 96 hours** Lecture training hours – 48 hours Practical training hours – 48 hours **Independent study – 144 hours**
Course work	No
ECTS	8
The purpose and tasks of subject / learning outcomes	**The purpose of teaching the subject is** to learn how bridges, overpasses, viaducts, culverts, tunnels and retaining walls carry loads and perform in service. They use preliminary calculations and inspection evidence to justify engineering decisions. **The objectives of teaching the subject** are to trace load paths and analyse site investigation data, loads and other actions. Compare reinforced concrete, prestressed concrete, steel and composite superstructures. Assess supports, foundations, joints, bearings and drainage, and explain how culverts, tunnels and retaining walls function. Account for scour, defects, corrosion and seismic effects when recommending investigations, monitoring and maintenance or repair over a structure’s life. **Learning outcomes:** 1. Explain the functions, classification, main components, structural systems and life cycle stages of highway structures. 2. Analyse topographic, geotechnical, hydrological, traffic and in-service data to identify the conditions governing a calculation model. 3. Quantify loads and other actions with appropriate units, form simple combinations under the specified design code and calculate internal forces in a simple span. 4. Compare the behaviour of reinforced concrete, prestressed concrete, steel and composite bridge superstructures and perform preliminary checks using a given model. 5. Identify the functions and typical defects of supports, foundations, bearings, expansion joints, bridge decks and drainage systems. 6. Analyse the structural and operational characteristics of culverts, tunnels and retaining walls, including their interaction with water, soil and the road. 7. Compile a defect register from inspection and non-destructive testing evidence, identify method limitations and specify where further investigation is needed. 8. Compare maintenance, repair and strengthening options in light of structural condition, environmental exposure and construction constraints. 9. Prepare a digital asset record and a monitoring plan. Check the consistency of geometry, defect records and observations. 10. Justify intervention priorities using risk, durability, traffic impacts and life cycle costs, and defend an individual engineering report.
Course content (topics)	**I. Main Theoretical Part (Lecture Sessions).** Topics:

	1. Highway structures and their life cycles. 2. Design codes and limit states. 3. Bridge crossings and site data. 4. Loads and other actions. 5. Bridge structural systems. 6. Reinforced concrete slab and beam bridges. 7. Prestressed concrete. 8. Steel and composite steel–concrete bridges. 9. Bridge decks and approaches. 10. Bearings and expansion joints. 11. Abutments and piers. 12. Foundations and soil–structure interaction. 13. Culverts. Circular and box sections, headwalls, bedding and backfill. 14. Hydrology, bridge openings and scour. 15. Tunnels and retaining walls. 16. Construction and erection. 17. Deterioration mechanisms and defects. 18. Inspection, diagnosis and non-destructive testing. 19. Condition and load-carrying capacity. 20. Maintenance and repair. 21. Rehabilitation and strengthening. 22. Seismic, dynamic and extreme actions. 23. Digital inventory and monitoring. 24. Life cycle risk and work priorities. **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. Classify the structures along a road section in a table showing function, materials, structural system and life cycle characteristics. 2. Read a bridge general arrangement drawing and annotate the overall length, spans, clear opening, supports and deck components. 3. Determine permanent and traffic loads. Tabulate the prescribed combinations and check units for forces, line loads and area loads. 4. Construct an analysis model for a slab or beam bridge. Explain the load distribution, support reactions and load path. 5. Prepare a calculation sheet for a simple reinforced concrete beam. Check bending moment, shear force and section resistance under the given model. 6. Evaluate a prestressed beam in service. Calculate section stresses using the given prestressing force and losses, and check the model and units.

	7. Analyse a steel or composite superstructure. Sketch the cross-section and bracing, illustrate composite action and identify corrosion- and fatigue-sensitive details. 8. Inspect a bridge deck and approach. Mark defects in waterproofing, drainage, safety barriers and the transition on a drawing. 9. Calculate thermal movement and the required joint movement range. Document the fixed point, expansion length, temperature range and bearing movement. 10. Determine support reactions and verify equilibrium as forces pass from the superstructure through the cap beam to the foundation. 11. Compare shallow and piled foundations in a selection table covering geology, water conditions, settlement, scour and construction constraints. 12. Carry out preliminary hydraulic sizing of a culvert. Show discharge, the governing inlet or outlet condition, upstream and downstream water levels, and the selected section. 13. Interpret evidence of scour around a bridge support. Prepare a risk sheet linking channel conditions, water levels, foundation depth and countermeasures. 14. Assess a tunnel or retaining wall. Prepare an inspection record of seepage, cracks, deformation and drainage condition. 15. Diagram the erection sequence for a superstructure, identifying temporary design situations, bracing and quality control points. 16. Compile a photographic defect register with locations, dates and image identifiers. Record dimensions where a scale or measurement supports them and flag the rest for measurement. 17. Rate component condition against the teaching criteria. Record the evidence, uncertainty and recommendations for further investigation. 18. Interpret ultrasonic, rebound hammer or concrete cover readings. Explain the quality and limitations of the results. 19. Prepare an annual maintenance and routine repair schedule. List each activity, the reason for its priority, the evidence required to verify it and its impact on traffic. 20. Compare two repair or strengthening options in a table covering the cause of the defect, structural effects, constructability and costs. 21. Screen a bridge for seismic vulnerability. Identify critical signs at supports, joints, restraints and foundations and specify the need for further inspection. 22. Select protection for a corrosive environment. Justify drainage, waterproofing and protective measures for concrete and steel. 23. Create a digital asset record with verified coordinates, geometry, photographs, defects and intervention history. 24. Prioritise work on three to five structures using the specified risk, condition and life cycle criteria. Present the calculations and sensitivity analysis, and defend the ranking **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. Compare load models, combinations, serviceability checks and sources of design parameters in local bridge codes and the LRFD teaching approach.

	2. Inventory five to eight structures in a selected area using open or teaching data. Verify their classifications and data sources. 3. Compare structural layouts and conditions of use for reinforced concrete, prestressed concrete, steel and composite bridges. 4. Use a cause-and-effect diagram to analyse typical defects in bridge decks, joints, bearings, drainage and approaches. 5. Compare inspection and non-destructive testing methods in terms of their capabilities, the evidence obtained, calibration requirements and uncertainty. 6. Prepare a case study of a bridge or culvert exposed to flooding and scour, covering water, ground, structural and operating conditions. 7. Compare the engineering performance and construction requirements of repairs for concrete cracking, corrosion of reinforcement or structural steel, or joint failure. 8. Prepare a register of seismic vulnerabilities in the supports, joints, restraints and foundations of a bridge and identify emergency inspection needs. 9. Prepare a digital asset record integrating the geometry, components, photographs, defects and intervention history of a selected highway structure. 10. Develop a monitoring plan. Select measurements and response actions for settlement, displacement, vibration, cracking, corrosion and temperature. 11. Compare two maintenance or repair strategies over a common study period, identifying service-life assumptions, traffic impacts and life cycle costs. 12. Prepare and defend an individual report that critically assesses how monitoring evidence from the structural health monitoring review [7] could inform decisions for the structure under study.
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	CURRENT CONTROL

criteria and procedure	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,	10 points	

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<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>
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* 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. SHNQ 2.05.03-22. Bridges and Culverts. Order No. 109 of 15 June 2022, incorporating additions under Order No. 17 of 23 January 2024. lex.uz
2. Barker, R. M., Puckett, J. A. Design of Highway Bridges: An LRFD Approach. 4th ed. John Wiley & Sons, 2021. ISBN 9781119646297. www.wiley-vch.de
3. Precast/Prestressed Concrete Institute. PCI Bridge Design Manual. 4th ed., 2023. MNL-133-23. DOI 10.15554/MNL-133-23. www.pci.org
4. Ryan, T. W., Lloyd, C. E., Pichura, M. S., Tarasovich, D. M., Fitzgerald, S. Bridge Inspector’s Reference Manual (BIRM) (2022 NBIS). FHWA/NHI, March 2023. FHWA-NHI-23-024. rosap.ntl.bts.gov
5. Hung, C. J., Wisniewski, J., Monsees, J., Munfah, N. Technical Manual for Design and Construction of Road Tunnels—Civil Elements. FHWA/NHI, December 2009. FHWA-NHI-10-034. rosap.ntl.bts.gov
6. Deng, Z., Huang, M., Wan, N., Zhang, J. The Current Development of Structural Health Monitoring for Bridges: A Review. Buildings, 13(6), 2023, 1360. DOI 10.3390/buildings13061360. www.mdpi.com
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