Name of subject	ASPHALT CONCRETE TECHNOLOGY (10 ECTS)
Subject/module code	**AT23410**
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	Elective
Training hours (this including independent education)	**Total hours – 300 hours** **Contact hours – 120 hours** Lecture training hours – 48 hours Practical training hours – 48 hours Laboratory classes – 24 hours **Independent education – 180 hours**
Course work	No
ECTS	10
The purpose and tasks of subject / learning outcomes	**The purpose of teaching the subject is** to relate the composition and properties of asphalt concrete to material selection, mix design, production, transport, paving and compaction. Use test evidence to assess the quality of the resulting mix and pavement layer. **The objectives of teaching the subject** are to characterise bitumen, aggregates and mineral filler. Calculate aggregate gradation and mix volumetrics, and compare Marshall, Superpave and performance-based approaches to mix selection. Evaluate hot, warm, cold and special-purpose mixes. Calculate material flows and production rates from plant to pavement. Sample, prepare and test materials, then interpret the effects of moisture, temperature, ageing, modifiers and reclaimed material. Support conclusions about quality, resources, energy and cost with traceable calculations. **Learning outcomes:** 1. Distinguish an asphalt mixture from the compacted pavement layer and explain how each constituent contributes to structure and performance. 2. Characterise bitumen, aggregates and mineral filler using specified requirements and test data. Explain the effects of temperature, ageing and moisture. 3. Calculate combined aggregate gradation and constituent masses. Check the moisture correction and mass basis when balancing the mix. 4. Calculate bulk specific gravity of compacted mix (Gmb), theoretical maximum specific gravity of the mix (Gmm), air voids, voids in mineral aggregate (VMA) and voids filled with asphalt (VFA). Identify the mass fractions and test methods used. 5. Distinguish Marshall from Superpave procedures and justify a mix design using volumetric and performance test results. 6. Test bitumen, aggregate and asphalt specimens by the specified methods. Document test conditions and calculations from the original readings to the result. 7. Describe the production and construction sequence from proportioning, drying and mixing through hauling, paving and compaction. Identify the quality checks at each stage. 8. Calculate mix tonnage and plant, haulage, paver and roller output in consistent units. Identify the operation that limits production.

	9. Assess rutting, cracking, moisture resistance and compaction separately. State the limits of each test when interpreting pavement service life. 10. Compare modified binders, warm-mix asphalt, stone mastic asphalt (SMA) and reclaimed asphalt pavement (RAP) in terms of compatibility, testing, production and resource demand. 11. Check records and test results for incoming materials, production and acceptance against the specified criteria. Use evidence to investigate the cause of a defect. 12. Prepare and defend an individual engineering report that connects mix design, test results and process calculations. Justify the decision in terms of cost and environmental effects.
Course content (topics)	**I. Main Theoretical Part (Lecture Sessions).** Topics: 1. Asphalt concrete technology. 2. Composition, structure and mix types. 3. Paving bitumen. 4. Aggregates and mineral filler. 5. Bitumen rheology and ageing. 6. Aggregate blending. 7. Mix volumetrics. 8. Mix design methods. 9. Balanced mix design. 10. Sampling and test quality. 11. Hot, warm and cold mixes. 12. Asphalt plants and proportioning. 13. Mix production. 14. Transport and storage. 15. Paving. 16. Compaction. 17. Permanent deformation at high temperatures. 18. Low-temperature and fatigue cracking. 19. Water and moisture resistance. 20. Modified binders and additives. 21. SMA and special-purpose mixes. 22. RAP and recycling. 23. Quality control and acceptance. 24. Energy, environmental effects and process selection. **II. Instructions and recommendations for organizing laboratory exercises** The twelve laboratory exercises follow the existing syllabus. Record the method and edition, specimen, apparatus, conditions, raw readings, calculations and conclusion. Use prepared specimens where conditioning is lengthy. For specialist equipment, use a partner laboratory or verified test records. Label student measurements, demonstrations and supplied data separately. Work with hot binder, hot mix and the press under instructor supervision, using appropriate protection and ventilation. Topics: 1. Measure needle penetration of bitumen. Record the specimen, temperature, applied load, loading time and penetration result. 2. Determine bitumen softening point. Record the method, specimen preparation, heating procedure and repeat measurements. 3. Measure bitumen ductility. Record the specimen, water temperature, extension conditions and elongation at rupture.

	4. Determine the breaking point of bitumen using the specified apparatus. Record the cooling conditions and observed cracking. 5. Determine aggregate gradation. Record the dry specimen and mass retained on each sieve, check mass closure and plot the grading curve. 6. Determine aggregate density or specific gravity by the chosen method. Record the specimen condition, mass and volume readings, and calculation. 7. Prepare asphalt concrete specimens. Record the mix proportions, mixing sequence, temperature, compaction method and specimen identifiers. 8. Determine the bulk density of asphalt specimens. Record the masses, method of determining volume and comparable density results. 9. Determine water absorption of asphalt concrete. Record initial and wetted specimen conditions, conditioning and the method-specific absorption calculation. 10. Determine resistance to moisture damage. Compare the strength of conditioned and dry specimens tested by the same method and report the strength ratio and its limitations. 11. Determine compressive strength. Record specimen cross-section, temperature, loading conditions and failure load, then calculate strength. 12. Determine shear strength using the specified test arrangement. Record temperature, loading and measured response, and state the conclusion supported by the method. **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. Calculate aggregate fraction, filler and binder masses for a batch. Tabulate the mass balance and identify the reference mass used for each proportion. 2. Blend aggregate fractions from sieve data. Plot the combined grading curve and check it against the specified envelope. 3. Calculate binder and filler quantities. Convert the supplied percentages to a common basis using total mix mass or dry aggregate mass as appropriate. 4. Prepare a binder property sheet from penetration, softening point, ductility and breaking-point results. Record the temperature conditions for each test. 5. Verify G_{mb} and G_{mm} data. Tabulate masses, volume, water temperature and the conditions of the measurement method. 6. Calculate air voids, VMA and VFA. State the specific gravities and mass-fraction bases and check that the results are physically consistent. 7. Compare Marshall trial mixes. Plot stability, flow and volumetric properties against binder content.

	8. Analyse the supplied Superpave data. Compare gyratory compaction, volumetric criteria and binder selection with the corresponding Marshall procedure. 9. Choose between two trial mixes using volumetrics and the supplied rutting and cracking results. Record the evidence supporting the selection. 10. Assess test scatter and specimen quality. Tabulate replicates, the mean, possible causes of deviation and the need for retesting. 11. Compare hot, warm and cold mix processes in a table covering binder type, moisture, temperature or curing conditions, energy and control points. 12. Calculate plant feed quantities and output. Show batch or flow rate, cycle time, dry material requirements and moisture corrections. 13. Prepare a balance for drying and mixing showing wet and dry masses, water removed, component feed quantities and the quality properties to record. 14. Balance plant, truck and paver output. Calculate haul cycle time, payload and fleet size, and identify limits on waiting time and the temperature records required. 15. Select paver speed from the layer cross-section, compacted mass and delivery rate. Verify that supply supports continuous paving. 16. Plan the roller fleet and passes from working width, overlap, the compaction window and evidence from the trial section. 17. Compare rutting and shear tests. Write a performance interpretation that identifies temperature, loading, conditioning and the units for each result. 18. Interpret cracking and ageing data. Tabulate the test conditions, failure mechanism, result and limits of application to the pavement. 19. Calculate the ratio of conditioned to dry specimen strength under the specified procedure. Explain how this moisture-resistance measure differs from water absorption. 20. Compare polymer, rubber and hydrated lime options by dosage, incorporation method, compatibility, storage and test evidence. 21. Prepare a quality checklist for SMA or porous asphalt covering constituent functions, special requirements, tests and production controls. 22. Prepare a mix balance for dry RAP, virgin aggregate and binder. State the reclaimed binder content and the assumed fraction contributing to the new mix. 23. Prepare a lot acceptance report linking the sample and test to the criterion, uncertainty, corrective action and as-built record. 24. Compare the complete mix design, production and paving options. Present checked calculations, a process diagram, resource use, cost, environmental boundaries and an individual 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. Analyse binder properties and ageing from supplied test data. State the method, temperature, units and scope of the conclusion. 2. Select and blend aggregate fractions. Use each student's calculations to verify the combined gradation and mass balance. 3. Calculate Gmb, Gmm, air voids, VMA and VFA. Check the mass fractions referred to total mix and aggregate mass.

	4. Compare Marshall and Superpave data. Explain the preferred mix using volumetric and performance criteria. 5. Audit material and laboratory records. Trace the specimen, test conditions and replicates through to the reported calculation. 6. Calculate plant dosing, moisture corrections and output mass. Prepare a material-flow diagram. 7. Calculate the haul cycle from plant to paver and assess truck requirements, waiting time and temperature records. 8. Coordinate paver and roller operations. Relate layer mass, production rate and compaction window to trial-section evidence. 9. Compare rutting, shear and cracking tests by method and conditions. Draw a technical conclusion from the supplied results. 10. Analyse water absorption, moisture resistance and ageing results. Explain what each measure represents and support the likely causes. 11. Compare modifier, SMA or porous mix options. Identify compatibility requirements, special tests and production controls. 12. Calculate the material balance for a RAP mix. Document dry masses, binder content, the assumed reclaimed binder contribution and the need for verification. 13. Compare two technologies for resource use, cost and environmental effects. State the functional unit, system boundary and date of the data. 14. Use the 2023 Vermont balanced mix design study to compare volumetric and performance results. Explain the effect of production variability. 15. Combine the mix design, laboratory records and process calculations in an individual portfolio. Correct errors and defend the final decision.
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,	10 points	

<table>
<tr><td></td><td>
<table>
<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.
</td></tr>
<tr><td>Recommended Literature</td><td>
1. Papagiannakis, A. T., Masad, E. A. Pavement Design and Materials. 2nd ed. John Wiley & Sons, 2024. ISBN 9781394150175. www.wiley-vch.de
2. Hajj, E., Aschenbrener, T., Nener-Plante, D. Balanced Asphalt Mix Design: Eight Tasks for Implementation. TechBrief. FHWA, April 2022. FHWA-HIF-22-048. www.fhwa.dot.gov
3. Hettiarachchi, C., Mampearachchi, W. Handbook of Asphalt Technology. 1st ed. Springer Singapore, 2025. DOI 10.1007/978-981-96-4532-9. ISBN 9789819645329. link.springer.com
4. Ministry of Construction and Housing and Communal Services of Uzbekistan. QR 06.03-23, Highways. Construction regulations approved by Order No. 2 of 5 January 2024. lex.uz
5. Rogers, M., Enright, B. Highway Engineering. 4th ed. John Wiley & Sons, 2023. ISBN 9781119883302. www.wiley-vch.de
6. Hand, A. J., Aschenbrener, T. Asphalt Pavement Recycling Technologies. TechBrief. Federal Highway Administration, July 2023. FHWA-HIF-23-036. rosap.ntl.bts.gov
7. Nener-Plante, D., Schwartz, A., Veeraragavan, R. K., Tran, N., Myers, L. Balanced Mix Design Production Analysis of Asphalt Mixtures in Vermont. Transportation Research Record, 2677(11), 2023, 287–295. DOI 10.1177/03611981231165517. journals.sagepub.com
</td></tr>
</table>