Course title	Heat and Gas Supply Systems (ECTS 14)
Subject/module code	IGTT356714
Semester(s) in which the course is taught	5th, 6th and 7th semesters (2026–2027 academic year)
Assigned instructor	Toshmatov N.U., associate professor; Mansurova Sh.P., associate professor, Department of Engineering Communications
Language of instruction	Uzbek
Course type	Compulsory
Study workload (including independent study)	**Total workload – 420 hours** **Contact hours – 168** Lecture hours – 72 (24 per semester) Laboratory hours – 24 (7th semester) Practical class hours – 72 (24 per semester) **Independent study – 252 hours** (5th semester – 72; 6th semester – 72; 7th semester – 108) Course work – 6th semester; course project – 7th semester
ECTS	14 (5th semester – 4; 6th semester – 4; 7th semester – 6)
Course aims and objectives / learning outcomes	**The main aim of the course is to teach students the fundamentals of heat and gas supply, the design of these systems and their structural solutions, and the correct design and selection of system equipment and fittings; and to develop knowledge, initial skills and competence in the construction of heat and gas networks, installation, adjustment and testing works, and the operation of these systems.** **The objectives of the course are to provide students with theoretical knowledge and practical skills; to give them correct information on the fundamentals of heat and gas supply and their design; to teach them to select the necessary parameters when designing systems, to collect data and to apply design methods; to solve problems relating to the placement, design and selection of system equipment and fittings; to explain the process of their construction; to provide knowledge on performing technical and economic calculations for system operation; and to teach modern design methods.** **Prerequisites: Heat Engineering; Hydraulics.** **Learning outcomes:** **Professional competencies:** 1. Knows methods of determining the indoor microclimate, heat balance, heat losses and heat loads of buildings; is able to select heat supply system schemes, heat carriers and main equipment. 2. Calculates the hot water supply systems of buildings and selects the main equipment; is able to select gas supply system schemes and determine the design gas flow rate. 3. Performs the hydraulic calculation of external and internal gas pipelines; is able to select gas pressure regulating points and units, gas pressure regulators, gas meters and gas appliances. **Skills:** 4. Has sufficient competence in analysing the heat supply and hot water supply determined by calculation and in providing water and air heating systems. 5. Has the competence to assess the reliability, safety, energy efficiency and environmental performance of heat and gas supply systems. 6. Has the skills to prepare calculations and design documentation for heat and gas supply systems.
Course content (topics)	**I. Main theoretical section (Lectures) – 72 hours** **5th semester – 24 hours** **Topic 1**: District heating systems. (2 hours)**

	General concept of heat supply systems. Functions and importance of heat supply. [1, 3] **Topic 2: Heat energy sources. (2 hours)** Types of energy and heat sources used in heat supply. Boiler houses and combined heat and power plants. [2, 5] **Topic 3: Main consumers of heat energy. (2 hours)** Types of heat loads. Annual heat load. [3, 4] **Topic 4: Heat carriers. (2 hours)** Types of heat carriers, their advantages and disadvantages. [4, 6] **Topic 5: Centralised and local heat supply systems. (2 hours)** Types of heat networks. Ring (looped) and radial heat networks. [2, 6] **Topic 6: Heating substations. (2 hours)** Heating substations. Individual heating substations. Central heating substations. Equipment of heating substations. [3, 6] **Topic 7: Pipes and fittings used in heat networks. (2 hours)** Design of pipes and fittings. [4, 8] **Topic 8: Structural elements of heat networks. (2 hours)** Expansion joints (compensators) and supports of heat networks. [4, 6] **Topic 9: Methods of laying heat network pipelines. (2 hours)** Above-ground and underground laying of heat networks. Laying of heat networks in channels and without channels. [1, 7] **Topic 10: Hydraulic calculation of heat networks. (2 hours)** Sequence of hydraulic calculation for determining the diameter of a heat network and pressure losses. [12, 13] **Topic 11: Thermal insulation of heat networks. (2 hours)** Thermal insulation materials. Main purposes of using thermal insulation materials. [4, 5] **Topic 12: Energy efficiency and reliability of heat supply systems. (2 hours)** Automatic control of heat supply systems. [1, 3] **6th semester – 24 hours** **Topic 1: General concepts of building heating systems. (2 hours)** Description of heating systems. Main requirements for building heating systems. [1, 3] **Topic 2: Thermal regime of a building. (2 hours)** Thermal conditions and the creation of comfortable conditions for people in rooms. Thermal resistance of the external enclosing structures of buildings. [3, 6] **Topic 3**: Modern heating systems. (2 hours)** Structure of heating systems. Description of the main types of heating systems. [2, 6] **Topic 4: Water and steam heating systems. (2 hours)** One-pipe and two-pipe systems and their schemes. [4, 7] **Topic 5: Modern heat emitters used in heating systems. (2 hours)** Requirements for heat emitters. Selection and placement of heat emitters. [5, 6] **Topic 6: Heat-carrying pipes and auxiliary equipment of heating systems. (2 hours)** Placement of heat-carrying pipes in a building. Selection and calculation of auxiliary equipment of the heating system. [5, 7] **Topic 7: Determining the heat output of a heating system. (2 hours)** Heat balance of a room. Heat losses through individual enclosing elements of a room. [2, 10] **Topic 8: Hydraulic calculation of heating systems. (2 hours)** Determining the diameters of heating system pipes and pressure

	losses. [6, 7] **Topic 9: Hot water supply systems of buildings. (2 hours)** Types of hot water systems. Main elements of a hot water network. [3, 6] **Topic 10: Local hot water systems. (2 hours)** Autonomous gas water heaters. Individual hot water supply system based on a heating boiler. Selection of gas equipment when combining the heating system and hot water supply. [5, 7] **Topic 11: Hot water storage. (2 hours)** Design solutions for local hot water supply systems. Hot water storage. [7, 9] **Topic 12: Energy saving in heating and hot water supply systems. (2 hours)** Automated control and monitoring in building water supply systems. Solar heating and hot water supply systems. [2, 10] **7th semester – 24 hours** **Topic 1**: Composition and properties of gases. (2 hours)** Physical characteristics of gases. Properties and composition of gaseous fuel. Main physical and chemical properties of gases. Classification of combustible gases. [1, 4] **Topic 2**: Long-distance gas transmission. (2 hours)** Layout of main (trunk) gas pipelines. Structures on main gas pipelines. Pressure in main gas pipelines and intermediate compressor stations. [1, 4] **Topic 3: Urban gas networks. (2 hours)** Layout of urban gas supply systems. Classification of gas pipelines. Gas pipelines, their pressure and routing. [1, 5] **Topic 4: Ring (looped) and dead-end gas networks. (2 hours)** Schemes of looped and branched gas systems. Gas consumption standards. Non-uniformity of gas consumption. [4, 5] **Topic 5: Hydraulic calculation of gas networks. (2 hours)** Calculation of hourly, annual, specific, en-route (distributed), nodal and transit gas flow rates. Hydraulic calculation of low- and medium-pressure networks; calculation of gas pressure regulating points. [1, 4] **Topic 6: Pipes and fittings used in gas networks. (2 hours)** Pipes and fittings used in gas networks and the requirements for them. Gas pipeline equipment. Shut-off devices and fittings. [1, 5] **Topic 7: Gas pressure regulating points. (2 hours)** The gas pressure regulating point, its design and function. Schematic diagram of a gas pressure regulating point. [1, 4] **Topic 8: Coatings of pipes used in gas networks. (2 hours)** Application of coatings for pipes used in gas networks. Types of coatings and the requirements for them. [3, 4] **Topic 9: Underground and above-ground gas pipelines. (2 hours)** Routing of underground and above-ground gas pipelines and the requirements for their laying methods. Design and structure of gas pipelines. [1, 5] **Topic 10: Start-up, adjustment, testing and operation of gas systems. (2 hours)** Requirements for the start-up, adjustment and testing of gas systems and the specific features of carrying out this work. [3, 4] **Topic 11: Pressure in urban gas networks. (2 hours)** Pressure regulation in urban networks. Pressure regulators: their design, operating principle and classification. [4, 5] **Topic 12: Gas heating. (2 hours)** Main types of gas heating: gas-fired heating stoves, local gas heaters, infrared gas radiant heaters, gas–air heaters. [1, 4]

	** Topics developed on the basis of the curricula of universities ranked in the TOP-300 of the QS and THE rankings: Norwegian University of Science and Technology (NTNU, QS – 267). 5th semester, Topic 1 – district heating; 6th semester, Topic 3 – hydronic heating systems (course FENT2032); 7th semester, Topic 1 – gas characteristics and Topic 2 – gas transportation (course TPG4140). **II. Guidelines and recommendations for practical classes – 72 hours** Practical classes consolidate the theoretical material of the lectures and develop students' skills in calculating, designing and selecting the equipment of heat supply, heating, hot water supply and gas supply systems. **5th semester – 24 hours (2 hours each):** 1. Studying schematic diagrams of heat supply systems. 2. Determining the design heat load of a heat source. 3. Determining the heat carrier flow rate. 4. Drawing up the design scheme of a heat network. 5. Selecting heat pipe diameters. 6. Calculating pressure losses in a heat network. 7. Selecting pipeline fittings for heat networks. 8. Calculating heat losses in heat pipelines. 9. Selecting the thickness of thermal insulation. 10. Selecting pumps and determining their main parameters. 11. Studying heating substation schemes and selecting equipment. 12. Drawing up a comprehensive design scheme of a heat supply system. **6th semester – 24 hours (2 hours each):** 1. Selecting and drawing the scheme of a building heating system. 2. Determining the thermal resistance of a building's external enclosing structures. 3. Calculating the heat losses of building rooms. 4. Determining the design heat load of a heating system. 5. Selecting heat emitters and determining their number. 6. Determining the diameters of heating system pipes. 7. Selecting fittings and control devices in a heating system. 8. Performing the hydraulic calculation of a heating system. 9. Determining the standard and design flow rates of hot water. 10. Selecting pipe diameters for hot water supply. 11. Calculating and selecting a water heater and heat exchanger. 12. Drawing up the general scheme of a building's heating and hot water supply systems. **7th semester – 24 hours (2 hours each):** 1. Determining the physical and chemical properties of combustible gases and establishing the design parameters of gaseous fuel. 2. Drawing up the layout of main gas pipelines and selecting their main structures. 3. Selecting the layout of an urban gas supply system and classifying gas pipelines. 4. Drawing up schemes of looped and dead-end gas networks and determining the non-uniformity of gas consumption. 5. Determining the design flow rates of gas networks and performing their hydraulic calculation. 6. Determining pipe diameters in gas networks and selecting fittings. 7. Drawing up the schematic diagram of a gas pressure regulating point and selecting its main equipment. 8. Selecting and calculating corrosion protection coatings for gas pipelines. 9. Developing the routing scheme for underground and above-

	ground gas pipelines. 10. Organising the start-up, adjustment and testing of gas systems. 11. Regulating pressure in urban gas networks and selecting pressure regulators. 12. Selecting the type of gas heating system and calculating the main gas heating equipment. **III. Laboratory classes – 24 hours (7th semester, 6 hours each)** 1. Studying the elements of heating systems. 2. Testing elevators (jet pumps). Determining the heat transfer coefficient of heating devices connected to operating heating systems. 3. Studying the operating principle of gas meters. 4. Familiarisation with the operating principle, design features and technical operating rules of the TESTO 316-2 analyser. **IV. Independent study – 252 hours** Independent study develops students' ability to learn autonomously, to work with scientific and technical literature, regulatory documents and electronic resources, and to apply the knowledge gained in professional activity. Assignments are completed under the teacher's guidance in traditional or electronic form. **5th semester – 72 hours:** 1. Prospects for the development of heat supply systems in the Republic of Uzbekistan. (6 hours) 2. Methods of improving energy efficiency in heat supply systems. (6 hours) 3. Use of modern technologies in heat supply systems. (6 hours) 4. Development trends of district heating systems. (6 hours) 5. Selection of the heat carrier in water heat supply systems. (4 hours) 6. Technical and economic comparison of open and closed heat supply systems. (6 hours) 7. Advantages of condensate return systems. (6 hours) 8. Automatic control systems in heating substations. (6 hours) 9. Heat metering systems in heating substations. (4 hours) 10. Energy efficiency of pumping units in heat networks. (6 hours) 11. Parallel and series connection of pumps in heat networks. (6 hours) 12. Modern methods of laying heat networks underground. (4 hours) 13. Methods of reducing heat losses in heat networks. (6 hours) **6th semester – 72 hours:** 1. Prospects for the development of centralised hot water supply systems. (4 hours) 2. Types of hot water preparation sources. (4 hours) 3. Operating features of circulating hot water supply systems. (4 hours) 4. Operating features of closed hot water supply systems. (4 hours) 5. Water quality requirements in hot water supply systems. (4 hours) 6. Selection of pipe diameters in hot water supply systems. (4 hours) 7. Selection of gas equipment in hot water supply systems. (4 hours) 8. Types and design of hot water storage tanks. (4 hours) 9. Plate heat exchangers for hot water preparation. (4 hours) 10. Distribution of water flow in hot water supply pipelines. (4 hours) 11. Types and design of autonomous gas water heaters. (4 hours) 12. Reducing heat losses in hot water supply. (4 hours) 13. Modern pipe materials in hot water supply systems. (4 hours) 14. Modern fittings in hot water supply systems. (4 hours) 15. Main factors shaping the indoor microclimate. (4 hours) 16. Heat exchange of the human body and thermal comfort. (4

	hours) 17. Microclimate requirements for rooms with different functions. (4 hours) 18. Thermal protection of external enclosing structures. (4 hours) **7th semester – 108 hours:** 1. Operating principle of active heating systems. (6 hours) 2. Basic principles of passive heating systems. (6 hours) 3. Types and design of solar collectors. (4 hours) 4. Use of geothermal energy in heating systems. (6 hours) 5. Energy efficiency of heat pumps. (6 hours) 6. Integrated use of non-conventional energy sources. (6 hours) 7. Heating value of gaseous fuel. (4 hours) 8. Classification and fields of application of combustible gases. (6 hours) 9. Main structures on main gas pipelines. (4 hours) 10. Function of compressor stations on main gas pipelines. (6 hours) 11. Pressure regulation in gas transmission systems. (6 hours) 12. Principles of routing urban gas networks. (6 hours) 13. Comparison of looped and dead-end gas networks. (6 hours) 14. Seasonal non-uniformity of gas consumption. (6 hours) 15. Determining nodal flow rates in gas networks. (6 hours) 16. Pressure losses in gas networks. (4 hours) 17. Selection of pipe diameters in gas networks. (6 hours) 18. Steel pipes used in gas networks. (4 hours) 19. Use of polymer pipes in gas networks. (4 hours) 20. Modern types of gas heating appliances. (6 hours) **V. Course work (6th semester)** A comprehensive course work on building heating systems is provided in order to deepen and consolidate students' theoretical knowledge and to develop their skills in working with technical, reference and regulatory literature. **Topic of the course work:** "Design of a building heating system". Volume of the calculation and explanatory note – 20–30 pages. Number of drawings – 1–2. The graphic part of the course work includes: a typical floor plan of the building showing the heat emitters installed in the rooms, the heating system pipes and the duct ventilation system; depending on how the hot water mains of the heating system are laid, a basement or attic plan; and an axonometric diagram of the heating system. The explanatory note includes: initial data for calculating the heating system; climatic data for the district where the settlement is located; thermal calculation of the external enclosing structures; calculation of heat losses through the external enclosures; calculation of heat emitters; hydraulic calculation of the heating system; and selection and calculation of heating system equipment. The explanatory note is written on A4 paper in accordance with the following requirements: – paper size – A4 (210 × 297 mm); – margins – 2.5 cm on the left; 2 cm on the right, top and bottom; – font – Times New Roman; – page numbering – at the bottom centre of the page; – font size – 14 for the main text; – paragraph indent – 1.25 cm; – line spacing – 1.5; – text alignment – justified; – language – Uzbek (Latin script); – font size in drawings and tables – 12. **VI. Course project (7th semester)**

	Topic of the course project: "Design of a gas supply system". Volume of the calculation and explanatory note – 40–50 pages. Number of drawings – 1–2. A course project on district gas supply systems is provided in order to deepen and consolidate students' theoretical knowledge and to develop their skills in working with technical, reference and regulatory literature. The system developed must comply with the technical conditions for construction, installation and operation and with current design standards, and must be fit for purpose. The graphic part of the course project includes: the master plan of the district showing the routing of the gas supply networks; and the design scheme of the gas networks with the results of their hydraulic calculation. The explanatory note includes: determination of the annual and hourly design gas flow rates; hydraulic calculation of the gas networks; calculation of gas supply system equipment; and the number, location and gas throughput of gas pressure regulating points, together with the selection of sites for their construction. The explanatory note is written on A4 paper in accordance with the following requirements: – paper size – A4 (210 × 297 mm); – margins – 2.5 cm on the left; 2 cm on the right, top and bottom; – font – Times New Roman; – page numbering – at the bottom centre of the page; – font size – 14 for the main text; – paragraph indent – 1.25 cm; – line spacing – 1.5; – text alignment – justified; – language – Uzbek (Latin script); – font size in drawings and tables – 12. **VII. Teaching technologies and methods** – lectures; – interactive case studies; – seminars (logical thinking, rapid question-and-answer sessions); – group work; – presentations; – individual projects; – team projects for joint work and defence.
Student assessment	Student assessment is based on the level of mastery of the learning materials during the semester and final assessment (tests, assignments, and written and oral work). In each semester of the "Heat and Gas Supply Systems" course, students are assessed on a 100-point scale. Of this total, 50 points are allocated to current and midterm assessment (60% of these 50 points for ongoing assessment and independent study, and 40% for the midterm assessment), while 50 points are allocated to the final assessment. Students whose combined current and midterm score is below 30 points are not admitted to the final examination. A student who obtains 30 or more points in the final assessment is considered to have passed the course. **Assessment criteria:** **a) A grade of "5" (excellent) requires the student to:** – fully explain the essence and content of the course; – present the topics of the course in a scientific and logically consistent manner, without scientific errors or inaccuracies; – have a clear understanding of the theoretical or practical importance of the course material;

	– demonstrate the ability to think independently and freely within the scope of the course; – give clear and concise answers to the questions asked; – have a thoroughly prepared set of lecture notes; – complete independent assignments fully and accurately; – have mastered all the practical skills and competencies; – be able to apply theoretical knowledge in various situations; – take a systematic approach and maintain continuity. **b) A grade of "4" (good) requires the student to:** – understand the essence and content of the course and present its topics without scientific or logical inaccuracies; – understand the practical importance of the course content; – complete the tasks and assignments for the course within the scope of the syllabus; – give correct answers to the questions asked on the course; – have a well-prepared set of lecture notes for the course; – complete the independent assignments for the course in full; – have made an effort to master all the practical skills and competencies. **c) A grade of "3" (satisfactory) requires the student to:** – have a general understanding of the course; – cover the topics of the course within a narrow scope, allowing some inaccuracies in presentation; – complete the independent assignments for the course in full; – the presentation is not fluent; – answers to questions on the course are vague and confused; – the written work on the course is not carefully prepared. **d) A grade of "2" (unsatisfactory) may be given in the following cases:** – the student has not prepared for classes on the course; – the student has no understanding of the content of the classes; – the independent assignments for the course have not been completed in full; – there are signs that written work has been copied from others; – the written work contains serious errors and inaccuracies; – no answers are given to questions on the course, i.e. the student does not know the course.
Examination requirements	To earn the credits, the student must have fully mastered the theoretical and methodological concepts of the course, be able to present the results of analysis correctly, reason independently about the processes studied, complete the tasks and assignments given for assessment, and submit written work for the final assessment. Students who do not submit current assessment, midterm assessment and independent study assignments, or who score fewer than 30 points for these assignments and assessment components, are not admitted to the final assessment. Furthermore, a student who, without a valid reason, misses 25 percent or more of the contact hours allocated to the course will be withdrawn from the course, will not be admitted to the final examination, and will be considered not to have earned the relevant credits for the course. A student who fails the final examination or receives a score in the range of "0–29.9" for this examination is considered to have an academic debt.
Recommended literature	**Main literature:** 1. Toshmatov N.U. Issiqlik, gaz ta'minoti tizimlari [Heat and Gas Supply Systems]. Textbook. – Tashkent: Impress Media LLC, 2021. – 174 p.

	2. Tursunov M.K. Issiqlik ta’minoti tizimlari [Heat Supply Systems]. Study guide. – Jizzakh: JizPI printing house, 2023. – 122 p. 3. Saydullayev S.R. Issiqlik ta’minoti tizimlari (Issiqlik ta’minoti va issiqlik jarayonlari) [Heat Supply Systems (Heat Supply and Thermal Processes)]. Study guide. – Tashkent, 2021. – 205 p. 4. Meliyev B.O‘. Issiqlik gaz ta’minoti [Heat and Gas Supply]. Study guide. – Jizzakh: JizPI printing house, 2023. – 122 p. 5. Toshmatov N.U., Mansurova Sh.P. Issiqlik, gaz ta’minoti va ventilyatsiya asoslari [Fundamentals of Heat and Gas Supply and Ventilation]. Study guide. – Jizzakh: JizPI printing house, 2023. – 122 p. 6. Saydullayev S.R. Binolarning injenerlik kommunikatsiyalari [Engineering Communications of Buildings]. Textbook. – Jizzakh: JizPI printing house, 2021. – 203 p. **Additional literature:** 7. Azimova M.M. Issiqlik ta’minoti va issiqlik tizimlari [Heat Supply and Heating Systems]. Textbook. – Tashkent: Innovatsion rivojlanish nashriyot-matbaa uyi, 2024. – 284 p. 8. Rashidov Yu.K., Saidova D.Z. Issiqlik, gaz ta’minoti va ventilyatsiya tizimlari [Heat and Gas Supply and Ventilation Systems]. Study guide. – Tashkent: TACI, 2002. – 146 p. 9. Mamajonov T., Nurmonov S.R. Issiqlik ta’minoti [Heat Supply]. Study guide. – Tashkent, 2018. – 200 p. 10. Rashidov Yu.K., Tursunova U.X., Mamajonov T.M. Issiqlik ta’minoti [Heat Supply]. Study guide. – Tashkent: TACI, 2000. **Internet resources** 11. www.ziyonet.uz – Information and educational network of the Republic of Uzbekistan. 12. www.mc.uz – Ministry of Construction and Housing and Communal Services of the Republic of Uzbekistan.