Course title	Energy-Efficient Engineering Systems of Buildings (ECTS 6)
Subject/module code	BETMT2406
Semester(s) in which the course is taught	4th semester (2026–2027 academic year)
Assigned instructor	Mansurova Sh.P., associate professor, Department of Engineering Communications
Language of instruction	Uzbek
Course type	Elective
Study workload (including independent study)	**Total workload – 180 hours** **Contact hours – 72** Lecture hours – 36 Laboratory hours – none Practical class hours – 36 **Independent study – 108 hours** Course project – none
ECTS	6
Course aims and objectives / learning outcomes	**The main aim of the course is to develop students' knowledge, skills and competence, in line with their field of study, concerning the engineering equipment used in the energy-efficient engineering systems of buildings: the types and designs of these systems, their scope of application, the fundamentals of their calculation, and methods of selecting them to suit specific conditions.** **The objective of the course is to teach students the theory of calculating the energy-efficient engineering communication systems of buildings, their types and structure, and their role in providing a comfortable microclimate for people's work and life; and to teach them to select and calculate suitable systems for the efficient use of non-conventional heat and gas supply systems.** **Prerequisites: Mathematics; Physics.** **Learning outcomes:** **Professional competencies:** 1. Has an understanding of heating systems and district heating systems; cooling and ventilation systems; and the gas supply networks and equipment of buildings. 2. Has an understanding of the cold and hot water supply networks and equipment of buildings; the wastewater networks and equipment of buildings; and the pressure-boosting devices used in the cold water supply systems of buildings. 3. Knows the heating equipment of central heating systems; the types and main technical characteristics of air conditioners; and the pipes and gas pipeline equipment used in gas distribution systems. **Skills:** 4. Knows water pipes and fittings, pumping units and sanitary equipment. 5. Has the skills to perform the thermal calculation of enclosing structures and to calculate heat losses through enclosing structures.
Course content (topics)	**I. Main theoretical section (Lectures) – 36 hours** **Topic 1: Energy efficiency and energy certification of buildings. (2 hours)** Typology and certification of buildings by energy efficiency class. [1, 3] **Topic 2: Heat transfer. (2 hours)** Basic concepts of heat transfer. Heat transfer by conduction, convection and radiation. [2, 5] **Topic 3: General information on heating. (2 hours)** Description of heating systems. Main requirements for heating systems. Local and central heating systems. [3, 4] **Topic 4: Modern heat emitters and equipment used in heating**

	systems. (2 hours) Requirements for heat emitters. Selection and placement of heat emitters. [4, 6] **Topic 5**: Energy-saving methods in heating systems. (2 hours)** Methods of saving heat used for heating. Improving the efficiency of building heating systems. [2, 6] **Topic 6: District heating systems and equipment. (2 hours)** Types of heat loads. Connection of consumers to heat supply systems. [3, 6] **Topic 7: Heating substations. (2 hours)** Individual and central heating substations. Heating substation equipment. [4, 8] **Topic 8: Building ventilation systems. (2 hours)** General information on ventilation. Methods of organising air exchange. [4, 6] **Topic 9: Equipment and units of ventilation systems. (2 hours)** Fans, deflectors, air heaters, filters. [1, 7] **Topic 10: Air-conditioning systems. (2 hours)** Basic concepts of air conditioning. Schematic diagrams of air-conditioning systems. [12, 13] **Topic 11: Equipment of air-conditioning systems. (2 hours)** Air-conditioning units. Central air conditioners. Local air conditioners. [4, 5] **Topic 12**: Achieving energy efficiency in ventilation and air-conditioning systems. (2 hours)** Reducing heat energy consumption in ventilation systems. Heat recovery in air-conditioning systems. [5, 6] **Topic 13: Elements of building gas supply systems. (2 hours)** Sources of gas supply for buildings. [5, 7] **Topic 14: Water supply systems of buildings. (2 hours)** Water supply schemes and systems. Classification of cold water systems. [6, 8] **Topic 15: The concept of hot water systems and their energy efficiency. (2 hours)** Types of hot water systems. Main elements of a hot water network. Centralised and local hot water systems. [5, 7] **Topic 16: Use of solar energy in hot water supply systems. (2 hours)** Solar hot water supply systems. Main equipment of solar hot water supply installations. [3, 6] **Topic 17: Sewerage networks and schemes. (2 hours)** Providing buildings with internal sewerage networks. The internal sewerage system of a building and its types. [4, 5] **Topic 18: Energy saving in water supply and sewerage systems. (2 hours)** Improving the efficiency of building water supply and sewerage systems. Use of water-saving sanitary fixtures. [5, 8] ** Topics developed on the basis of the curricula of universities ranked in the TOP-300 of the world rankings: Technical University of Denmark (DTU, ARWU – 170), course 41463. Topic 5 – building-integrated heating and cooling systems that use thermal energy efficiently, free cooling and integrated heat storage; Topic 12 – ventilation systems with efficient heat recovery and low energy consumption. **II. Guidelines and recommendations for practical classes – 36 hours** Practical classes consolidate the theoretical material of the lectures and develop students' skills in applying energy-efficiency policy and in

	calculating and selecting the equipment of energy-efficient heating, ventilation, air-conditioning, hot water supply, gas supply and wastewater systems of buildings. **Recommended practical topics (2 hours each):** 1. State policy of Uzbekistan in the field of improving energy efficiency. 2. Thermal calculation of enclosing structures. 3. Energy-efficient boilers for heating systems. 4. Underfloor heating systems. 5. Recuperators: their types and operating principles. 6. Expansion tanks of heating systems. 7. Structural elements of heat networks. 8. Schemes for organising air exchange. 9. Air curtains in ventilation systems. 10. Selecting and calculating air heaters for ventilation systems. 11. Design and operating principle of split air conditioners. 12. Chiller–fan-coil systems. 13. Main elements, operating principles and design of gas water heaters. 14. Selecting water meters. 15. Schemes for connecting hot water supply systems to heat networks. 16. Modern equipment and automatic control fittings in hot water supply systems. 17. Efficiency of solar collector hot water systems. 18. Equipment and fittings in the wastewater systems of buildings. **III. Laboratory classes** Laboratory classes are not provided for in the curriculum of this course. **IV. Independent study – 108 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. **Topics recommended for independent study:** 1. Energy-efficient windows. (4 hours) 2. Frame-panel (modular) air-handling units. (4 hours) 3. Thermal insulation of heat networks. (4 hours) 4. The "smart home" system. (4 hours) 5. Ventilation ducts and air ducts. (4 hours) 6. Chiller–fan-coil systems. (4 hours) 7. Filters used in ventilation systems. (4 hours) 8. Use of polymer pipes in heating systems. (4 hours) 9. Air vents (air collectors) used in heating systems. (4 hours) 10. Sources of cooling for air-conditioning systems (refrigerants). (4 hours) 11. Pressure control in heating systems. (4 hours) 12. Noise and vibration control in ventilation systems. (4 hours) 13. Control and shut-off fittings used in heating systems. (4 hours) 14. Air intake chambers. (4 hours) 15. Thermostats: their design and operating principle. (4 hours) 16. Energy-efficient buildings. (6 hours) 17. Properties of gas. (4 hours) 18. Underground and above-ground gas pipelines. (4 hours) 19. Hot water quality requirements. (4 hours) 20. Energy-efficient control systems in water pumping stations. (6 hours)

	21. Use of renewable energy sources in the design of building engineering systems. (4 hours) 22. Domestic gas appliances. (4 hours) 23. Infrared radiant heaters. (4 hours) 24. Passive houses. (4 hours) 25. Storage tanks in hot water supply systems. (4 hours) 26. Automation of the engineering systems of multi-storey buildings. (4 hours) **V. 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). Throughout the "Energy-Efficient Engineering Systems of Buildings" 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. Saydullayev S.R. Binolarning injenerlik kommunikatsiyalari [Engineering Communications of Buildings]. Textbook. – Jizzakh: JizPI printing house, 2021. – 203 p. 3. Mansurova Sh.P. Ventilyatsiya va havoni konditsiyalash tizimlari [Ventilation and Air-Conditioning Systems]. Textbook. – Jizzakh: So'g'diyona nashriyot matbaa uyi, 2023. – 153 p. 4. 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. 5. Toshmatov N.U., Mansurova Sh.P., Obidov N.A. Qurilish issiqlik fizikasi [Building Thermal Physics]. Study guide. – Jizzakh: JizPI, 2025. – 124 p. 6. Mansurova Sh.P. Qayta tiklanuvchi energiya manbalaridan foydalanish [Use of Renewable Energy Sources]. Study guide. – Jizzakh: So'g'diyona nashriyot matbaa uyi, 2023. – 48 p. **Additional literature:** 7. Tulakov E.S. Binolarning energiya samaradorlik injeneringi [Energy Efficiency Engineering of Buildings]. Study guide. – Samarkand: Samarkand State Institute of Architecture and Civil Engineering, 2020. – 238 p. 8. Протасевич А.М. Энергосбережение в системах теплогазоснабжения, вентиляции и кондиционирования воздуха [Protasevich A.M. Energy Saving in Heat and Gas Supply, Ventilation

and Air-Conditioning Systems]. Study guide. – Minsk: Novoe znanie; Moscow: INFRA-M, 2012. – 286 p.

9. Зуев К.И. Автоматизация систем водоснабжения и водоотведения [Zuev K.I. Automation of Water Supply and Wastewater Systems]. Study guide. – Vladimir: Vladimir State University named after the Stoletovs, 2016. – 224 p.

10. Опарина Л.А. Основы ресурсо- и энергосбережения в строительстве [Oparina L.A. Fundamentals of Resource and Energy Saving in Construction]. Study guide. – Ivanovo: PresSto, 2014. – 256 p.

11. Шафлик В. Современные системы горячего водоснабжения [Shaflik V. Modern Hot Water Supply Systems]. – Kyiv: Taki spravy, 2010. – 316 p.

Internet resources

12. www.ziyonet.uz – Information and educational network of the Republic of Uzbekistan.

13. www.mc.uz – Ministry of Construction and Housing and Communal Services of the Republic of Uzbekistan.