Name of subject	Modern heating systems of buildings (ECTS 6)
Subject/module code	BZIT35606
Science taught semester (s).	5st and 6nd semesters
Responsible teacher	Saydullayev Sirojiddin Rahmatullayevich, Associate Professor
Education language	Uzbek
Connection to the curriculum	Elective
Training hours (this including independent education)	**Total hours-180.** **Audience Training hours - 72.** Lecture training hour – 36 Practical training hour – 36 **Independent education -108 hours**
ECTS	6
The purpose and tasks of subject / learning outcomes	**The purpose of teaching science -** The aim of the course is to equip students with theoretical knowledge and practical skills related to the design, structure, operating principles, energy-efficient technologies, automatic control systems, and effective operation of heating and domestic hot water supply systems used in modern buildings. The course also aims to provide students with knowledge of improving the energy efficiency of buildings, utilizing renewable energy sources, and implementing modern engineering solutions. **The task of science is to** reveal the role and importance of science in human life and society by providing students with theoretical knowledge, practical skills, a methodological approach to financial phenomena and processes, and a scientific worldview. **Learning outcomes:** 1. introduce students to the types, components, and operating principles of modern heating and domestic hot water supply systems in buildings; 2. teach students how to determine the heating loads of buildings and apply the principal calculation methods for heating systems; 3. explain the advantages and applications of radiator heating, convector heating, underfloor heating, air heating, and combined heating systems; 4. develop the ability to analyse centralized and autonomous heat supply systems; 5. provide knowledge of the principles of designing, calculating, and operating domestic hot water supply systems; 6. explain the operating principles of modern heat generators, including condensing boilers, heat pumps, and solar thermal collectors; 7. teach students to apply automation, control, and monitoring devices in heating and domestic hot water supply systems; 8. develop practical skills in performing hydraulic and thermal calculations of engineering systems; 9. develop competencies in the design and operation of heating and domestic hot water supply systems in accordance with current regulatory documents, construction standards, and occupational safety requirements.
Course content (topics)	**I. Main Theoretical Part (Lecture Sessions)** **Topic 1:** Introduction to Heating Systems and Their Classification. Fundamentals of Heat Energy Calculations. **Topic 2:** Hydronic Heating Systems and Their Components. **Topic 3:** Solar Energy and Heat Balance. Heating Systems Utilizing Solar Energy. **Topic 4:** Boiler Plants: Classification and Design.

Topic 5: Heating Systems Based on Heat Pumps..
Topic 6: Radiator Heating Systems.
Topic 7: Underfloor and Wall Heating Systems.
Topic 8: Air Heating Systems.
Topic 9: Automatic Capacity Control and Shunt Systems.
Topic 10: Thermal Storage Tanks and Energy Storage Systems.
Topic 11: Energy Saving in Modern Heating Systems. Environmental and Economic Assessment of Heating Systems.
Topic 12: Energy Performance Reporting and Certification Systems.
Topic 13: Assessment of Building Energy Performance and Energy Auditing.
Topic 14: Smart Heating Systems and Digital Control Technologies.
Topic 15: Building Automation and Control of Heating Systems Based on BMS.
Topic 16: Hybrid Heating Systems and Integration of Renewable Energy Sources.
Topic 17: Hydraulic Calculation, Balancing, and Optimization of Heating Systems.
Topic 18: Design, Modelling, and Technical and Economic Assessment of Heating Systems.

II. Practical training instructions and recommendations

The teacher's preparation for a practical training session begins with the study of preliminary documents (curriculum, thematic plan, etc.) and ends with the development of a lesson plan. The teacher should have an idea of the goals and objectives of the practical training session, the amount of work that each student must perform.

Methodological guidelines are the main methodological document of the teacher in preparing and conducting practical training sessions.

The purpose of the practical training session is to understand the theory, acquire skills. It is to consciously apply it in educational and professional activities, and to develop the ability to confidently form one's own point of view.

The following topics are recommended for practical training:

1. Thermal Engineering Calculations of Building Envelope Structures.
2. Calculation of Heat Losses Through Room Enclosure Structures.
3. Thermal Calculation of Heating Appliances.
4. Hydraulic Calculation of Heating Systems.
5. Development of a Piping Layout and Selection of Components for a Two-Pipe Hydronic Heating System Using VALTEC Software.
6. Calculation of the Impact of Solar Energy on Walls and Windows (A South-Facing Room).
7. Development of an Underfloor Heating Layout for a 30 m^2 Room and Analysis of Temperature Distribution Using VALTEC Software.
8. Calculation of Airflow Rates for an Air Heating System Using Air Ducts.
9. Comparison of Heating Systems With and Without Zonal Temperature Control Using Simulation.
10. Performance Assessment of a 500-Litre Thermal Storage Tank and Calculation of Heat Retention Time.
11. Development of a Schematic Diagram and Performance Analysis of an Integrated Solar Collector, Hot Water Storage Tank, and Boiler System.
12. Determination of the Energy Balance and Energy Performance Certificate of a Two-Room Apartment Based on the UNI/TS

11300-1 Standard.

13. Conducting a Building Energy Audit and Identifying Energy-Saving Potential.

14. Development of a Heating System Control Algorithm Based on Smart Thermostats and Sensors.
15. Development of a Heating System Monitoring and Automatic Control Scheme Using a Building Management System (BMS).
16. Development of a Hybrid Heating System Scheme Integrating Solar Collectors, Heat Pumps, and Boilers, and Calculation of Its Energy Balance.
17. Performing Hydraulic Calculations of a Heating System and Selecting Pipe Diameters and Pump Operating Parameters.

18. Design of a Modern Building Heating System and Assessment of Its Technical and Economic Efficiency.

IV. Independent learning and independent work.

Independent learning competence serves to support students' independent self-development and increase the effectiveness of professional activities. Students perform independent work on their mobile devices under the guidance of a teacher in a traditional or electronic form.

Recommended topics for independent study:

1. Requirements for Domestic Hot Water Supply Systems.
1. Gas-Fired Water Heaters.
2. Electric Water Heaters.
3. Modern Domestic Hot Water Preparation Equipment. Solar Thermal Systems.
4. Storage-Type and Mixing-Type Water Heaters.
5. Domestic Hot Water Supply to Consumers from Central Heating Substations.
6. Centralized Domestic Hot Water Supply Systems.
7. Calculation of Domestic Hot Water Consumption in Buildings.
8. Decentralized Domestic Hot Water Supply Equipment.
9. Solar-Powered Equipment for Domestic Hot Water Production.
10. Domestic Hot Water Supply Systems Utilizing Solar Energy.
11. Construction, Selection, and Main Components of Solar Collectors.
12. Design of Domestic Hot Water Supply Systems Utilizing Solar Energy.
13. Calculation of Solar-Powered Domestic Hot Water Supply Equipment.
14. Sanitary Fixtures, Pipelines, and Valves Installed in Domestic Hot Water Supply Systems.
15. Requirements for Domestic Hot Water Supply Systems.
16. Gas-Fired Water Heaters.
17. Electric Water Heaters.

18. Modern Domestic Hot Water Preparation Equipment. Solar Thermal Systems.

19. Storage-Type and Mixing-Type Water Heaters.
20. Domestic Hot Water Supply to Consumers from Central Heating Substations.
21. Centralized Domestic Hot Water Supply Systems.
22. Calculation of Domestic Hot Water Consumption in Buildings.
23. Decentralized Domestic Hot Water Supply Equipment.
24. Solar-Powered Equipment for Domestic Hot Water Production.
25. Domestic Hot Water Supply Systems Utilizing Solar Energy.
26. Construction, Selection, and Main Components of Solar Collectors.
27. Design of Domestic Hot Water Supply Systems Utilizing Solar

	Energy. 28. Calculation of Solar-Powered Domestic Hot Water Supply Equipment. 29. Sanitary Fixtures, Pipelines, and Valves Installed in Domestic Hot Water Supply Systems.
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	90-100	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 the number of tasks)	18 points
		Student activity (in seminars, practical, laboratory classes)	10 points	
Midterm assessment	20 points	Supervision: Written work	10 points	12 points
		System tasks	10 points (divided by the number of tasks)	
Final assessment	50 points	Written assignment (5 questions)	50 points (10 points per question)	30 points
* 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.				

Recommended Literature

Main literature:

2. Boboev, S., Shukurov, G., Ismanhodjaeva, M. *Heating*. Textbook. Yangi Asr Avlodi Publishing House, 2008, 298 p.

3. Saydullayev, S.R. *Heat Supply Systems (Heat Supply and Thermal Processes)*. Study Guide. Tashkent, 2021, 205 p.

4. Saydullayev, S.R. *Engineering Utility Systems in Buildings*. Textbook. Tashkent, 2021.

5. Yunusov, B., Azimov, M. *Heat Supply and Heating Networks*. Study Guide. Tashkent, 2014.

6. Saydullayev, S.R. *Calculation of Engineering Utility Systems Using Computer Software*. Study Guide. Jizzakh Polytechnic Institute (JizPI), 2022.

Additional literatures

7. Mirziyoyev Sh.M. 2019 — 2030-yillar davrida O‘zbekiston Respublikasining “yashil” iqtisodiyotga o‘tish strategiyasini tasdiqlash to‘g‘risidagi O‘zbekiston Respublikasi Prezidentining qarori, 04.10.2019 yildagi PQ-4477-son.

8. Mirziyoyev Sh.M. Tanqidiy tahlil, qat’iy tartib-intizom va shaxsiy javobgarlik – har bir rahbar faoliyatining kundalik qoidasi bo‘lishi kerak. O‘zbekiston Respublikasi Vazirlar Mahkamasining 2016 yil yakunlari va 2017 yil istiqbollariga bag‘ishlangan majlisidagi O‘zbekiston Respublikasi Prezidentining nutqi. //“Xalq so‘zi” gazetasi. 2017 y., 16 yanvar, №11.

9. O‘zbekiston Respublikasi Konstitutsiyasi. - T.: O‘zbekiston, 2017. - 46 b.

10. O‘zbekiston Respublkasini yanada rivojlantirish bo‘yicha Harakatlar strategiyasi to‘g‘risida. - T.:2017 yil 7 fevral, PF-4947-sonli Farmoni.

11. Tulakov, E.S. *Energy Efficiency Engineering of Buildings*. Study Guide. Samarkand State Institute of Architecture and Civil Engineering. Samarkand, 2020, 238 p.

12. Mansurova, Sh.P. *Utilization of Renewable Energy Sources*. Study Guide. Jizzakh: Sugdiyona Publishing and Printing House, 2023, 48 p.

13. Rashidov, Yu.K., Koroli, M.A. *Heating*. Study Guide. 2000, 96 p.

14. Tursunova, U.Kh., Mamajonov, T.M. *Heat Supply*. Study Guide. Tashkent: Talkin, 2004, 126 p.

15. Duffie, J.A., Beckman, W.A. *Solar Engineering of Thermal Processes*. New Jersey, 2013.

Internet resources:

1. www.ziyonet.uz – national educational materials search site.
2. www.gov.uz – Government portal of the Republic of Uzbekistan.
3. www.google.com – international educational materials search site.
4. www.energystrategy.ru – Information portal "Energy Policy and Strategy"
5. ww.twirpx.com – international educational materials search site.

No.	Name of HEI	QS	THE	Topic title in this syllabus	Additional topics included based on TOP-300 educational programmes	Links:
1	**Norway's Norwegian University of Science and Technology (NTNU), ranked 267th in the QS World University Rankings (Top 300), Department of Energy and Process Engineering (EPT), study programme: "Heating and Cooling Systems in Buildings".**	**267**	**298**	**Topic 9. Automatic Heating Capacity Control and Shunt Systems.**	**Topic 9. Automatic Heating Capacity Control and Shunt Systems (Capacity Control and Shunt Systems)** Types and operating principles of automatic heating capacity control. Shunt systems and their functions. Zonal temperature control and weather-compensated control based on outdoor air temperature.	https://www.ntnu.edu/studies/courses/FENT2032?utm_source=chatgpt.com#tab=omEmnet
				Topic 10. Thermal Energy Storage Tanks and Energy Storage Systems.	**Topic 10. Thermal Energy Storage and Energy Storage Systems (Heat Storage in Hydronic Systems)** Types and construction of thermal energy storage systems. Main purposes of thermal energy storage. Factors affecting system efficiency and methods of optimization.	