Course title	Use of Alternative Energy Sources (ECTS 4)
Subject/module code	MEMF4704
Semester(s) in which the course is taught	7th semester (2027–2028 academic year)
Assigned instructor	Mansurova Sh.P., associate professor, Department of Engineering Communications
Language of instruction	Uzbek
Course type	Compulsory
Study workload (including independent study)	**Total workload – 120 hours** **Contact hours – 48** Lecture hours – 24 Laboratory hours – none Practical class hours – 24 **Independent study – 72 hours** Course project – yes
ECTS	4
Course aims and objectives / learning outcomes	**The aim of the course is to teach the physical processes that take place in a building and its elements, and the effect of these processes on the building and on people.** **The objective of the course is to master the features of how the indoor microclimate of rooms is formed and the methods that ensure its reliability and long-term durability.** **Prerequisites: (FIZ11204) Physics; (IVHKT356714) Heating, Ventilation and Air-Conditioning Systems.** **Learning outcomes:** **Professional competencies:** 1. Has an understanding of the classification of systems for using non-conventional and renewable energy sources. 2. Has an understanding of the problems arising from the limited nature of energy resources and of the use of these resources. 3. Has an understanding of the development trends in obtaining energy by non-conventional methods. 4. Knows and is able to apply methods of quality control of work on the use of non-conventional and renewable energy sources. **Skills:** 5. Has the skills to apply methods of using non-conventional and renewable energy resources in engineering systems. 6. Knows the methods of testing, adjusting and operating equipment for the use of non-conventional and renewable energy, and has the skills to apply them.
Course content (topics)	**I. Main theoretical section (Lectures) – 24 hours** **Topic 1*: Fundamentals of solar energy. (2 hours)** Characteristics of solar radiation. Solar energy: the fundamentals, practice and future of its use. Obtaining heat and electricity from solar energy. [2, 5] **Topic 2: Solar collectors. (2 hours)** Types of solar collectors. Design of flat-plate solar collectors. Concentrating solar collectors. Evacuated tube solar collectors. [1, 5] **Topic 3: Solar hot water supply systems. (2 hours)** Solar hot water supply systems. Classification of solar hot water supply systems. Basic schemes of solar hot water supply systems. [2, 4] **Topic 4: Solar heating systems. (2 hours)** Classification of solar heating systems. Passive and active solar heating systems. Types of passive solar heating systems. [5, 6] **Topic 5: Use of wind energy. (2 hours)** Main meteorological characteristics of wind. Climatic characteristics of wind energy. [1, 5] **Topic 6: Classification of wind power installations. (2 hours)**

	Wind generators and their operating principles. Classification of wind power installations. Horizontal-axis and vertical-axis wind turbines. [2, 3] **Topic 7: Use of water energy. (2 hours)** Hydropower. Use of the energy of natural waters. Design and operating principle of a hydroelectric power plant (HPP). Small and micro hydroelectric power plants. [5, 8] **Topic 8*: Ocean energy. (2 hours)** Wave energy; energy generated by currents in oceans and along sea coasts, and methods of using it. Wave and tidal (current) power plants. [2, 7] **Topic 9: Geothermal energy. (2 hours)** Use of geothermal energy. Use of geothermal waters. Thermal waters and steam–water mixtures, and steam–water thermal resources in underground reservoirs. [5, 6] **Topic 10*: Biomass energy. (2 hours)** Types of biomass and their use. Methods of biomass processing. Biogas production. Biogas production technology. [5] **Topic 11*: Hydrogen production, hydrogen storage and hydrogen safety – fuel cells. (2 hours)** Types of hydrogen production. Hydrogen storage. Hydrogen safety – fuel cells (technology, challenges and fields of application). Current state and development trends of hydrogen energy. [5, 7] **Topic 12*: Various forms of energy storage. (2 hours)** Various forms of energy storage (pumped-storage power plants, compressed air, batteries, flow batteries, supercapacitors, flywheels). The energy storage process in renewable energy systems. [5, 7] * Topics introduced on the basis of the curricula of universities ranked in the TOP-300 of the QS and THE rankings. **II. Guidelines and recommendations for practical classes – 24 hours** Practical classes consolidate the theoretical material of the lectures and develop students' skills in selecting, calculating and evaluating installations that use solar, wind, water, geothermal, biomass and hydrogen energy, as well as energy storage systems. **Recommended practical topics (2 hours each):** 1. Solar power plants. 2. Solar water heaters. 3. Effective use of architectural and planning solutions of buildings in passive solar heating systems. Solar houses. 4. Solar (photovoltaic) panels: their design and operation. 5. Wind power plants: operating principle and schemes. 6. Wind generators. 7. Small hydroelectric power plants. 8. Structures for the use of water energy. 9. Use of heat pumps. 10. Design and operating principles of biogas plants. 11. Methods of hydrogen production, transport and storage. 12. The energy storage process in renewable energy systems: types and forms. **III. Laboratory classes** Laboratory classes are not provided for in the curriculum of this course. **IV. Independent study – 72 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. Impulse and reaction hydraulic turbines. (2 hours)
2. Design and characteristics of solar collectors. (4 hours)
3. Use of solar energy in Uzbekistan. (4 hours)
4. Open and closed water heaters. (2 hours)
5. Advantages and disadvantages of using biogas plants. (2 hours)
6. Solar air cooling. (2 hours)
7. Designing a heating system using heat pumps. (4 hours)
8. Energy-passive houses and their specific features. (4 hours)
9. Components of solar water heating installations. (2 hours)
10. Wind power plants: operating principle and schemes. (2 hours)
11. Small and micro hydroelectric power plants. (4 hours)
12. Use of geothermal waters and their classification. (2 hours)
13. Use of geothermal energy in the world and in Uzbekistan. (2 hours)
14. Technology of producing charcoal from wood. (4 hours)
15. Petrothermal power plants: their schemes and operating principle. (2 hours)
16. Types and methods of using geothermal heat. (4 hours)
17. Ocean thermal energy conversion power plants and their operating principle. (2 hours)
18. Use of wind energy in the world and in Uzbekistan. (2 hours)
19. Hydrogen energy. (4 hours)
20. The world's largest hydroelectric power plants. (4 hours)
21. Environmental value of biogas production. (4 hours)
22. Current state of water energy use in the world and in Uzbekistan. (2 hours)
23. Feedstock for biogas production. (4 hours)
24. Types of passive solar heating systems. (4 hours)

V. Course project

The aim of the course project is to develop students' ability to work independently; to build the skills to apply in practice the theoretical knowledge gained on renewable energy sources; to calculate and design hot water supply systems based on the use of solar energy; to make technical decisions suited to real conditions; and to gain proficiency in using modern equipment and technologies. The topics of the course project focus on studying the stages of designing hot water supply systems for buildings that use solar energy directly.

Indicative topic of the course project: "Design of a hot water supply system for a building using solar energy".

The initial data (variants) for the course project in "Use of Alternative Energy Sources" are taken from the methodological guidelines.

Each student receives an individual assignment. The assignment specifies the name of the city or district where the building being designed is located, the number of consumers in the building, the standard hot water consumption, the cold and hot water temperatures, the type of solar collector, the energy characteristics of solar radiation and the design parameters of the system. The calculation and graphic work of the course project is carried out on the basis of the recommended literature and the methodological guidelines.

The graphic part of the course project consists of 2–3 drawing sheets in A3 format showing: the site plan of the building being designed; the layout of solar collectors on the roof; the schematic diagram of the hot water supply system based on solar energy; the structural diagram of the heat storage tank; the layout of pipe networks and main equipment; the connection diagrams of the pump, heat exchanger, back-up heat source,

	and automatic control and monitoring devices; conventional symbols; and the equipment schedule. The explanatory note is 20–25 pages long and is prepared 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 of labels in drawings and tables – 12. On completing the course project, the student should have the skills to independently perform the calculations for a hot water supply system based on solar energy, select the necessary equipment, develop schematic and structural diagrams, and technically justify the design solutions. **VI. 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 "Use of Alternative Energy Sources" 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. Mansurova Sh.P. Qayta tiklanuvchi energiya manbalaridan foydalanish [Use of Renewable Energy Sources]. Study guide. – Jizzakh: So'g'diyona nashriyot matbaa uyi, 2023. – 139 p. 2. Mansurova Sh.P. Suv va energiya resurslaridan foydalanish va ularni muhofaza qilish [Use and Protection of Water and Energy Resources]. Study guide. – Jizzakh: Jizzakh Polytechnic Institute printing house, 2023. – 140 p. 3. Majidov T.Sh. Noan'anaviy va qayta tiklanuvchi energiya manbalari [Non-conventional and Renewable Energy Sources]. Textbook. – Tashkent: Voris-Nashriyot, 2014. – 168 p. 4. Клычев Ш.И., Мухаммадиев М.М., Авезов Р.Р., Потаенко К.Д. Нетрадиционные и возобновляемые источники энергии [Klychev Sh.I. et al. Non-conventional and Renewable Energy Sources]. Textbook for higher education institutions. – Tashkent: Fan va texnologiya, 2010. – 192 p.

	5. Toirov O.Z., Alimxodjaev K.T., Alimxodjaev Sh.K. Qayta tiklanuvchi energiya manbalari. O‘zbekiston sharoitida ishlab chiqarish va ishlatish istiqbollari [Renewable Energy Sources: Prospects for Their Production and Use in the Conditions of Uzbekistan]. Monograph. – Tashkent: Fan va texnologiya, 2019. – 212 p. **Additional literature:** 6. Попель О.С., Фортов В.Е. Возобновляемая энергетика в современном мире [Popel O.S., Fortov V.E. Renewable Energy in the Modern World]. Study guide. – Moscow: MPEI Publishing House, 2015. – 450 p. 7. Городов Р.В., Губин В.Е., Матвеев А.С. Нетрадиционные и возобновляемые источники энергии [Gorodov R.V., Gubin V.E., Matveev A.S. Non-conventional and Renewable Energy Sources]. Study guide. – Tomsk: Tomsk Polytechnic University Publishing House, 2009. – 294 p. 8. Радченко Р.В. Водород в энергетике [Radchenko R.V. Hydrogen in Power Engineering]. Study guide. – Yekaterinburg: Ural University Publishing House, 2014. – 229 p. **Internet resources** 9. www.ziyonet.uz – Information and educational network of the Republic of Uzbekistan. 10. www.mc.uz – Ministry of Construction and Housing and Communal Services of the Republic of Uzbekistan.