Name of subject	Solar heat supply systems (ECTS 6)
Subject/module code	QITT2106
Science taught semester (s).	1st semester
Responsible teacher	Abdullaev Elnur Akhmatovich, PhD., associate professor.
Education language	Uzbek
Connection to the curriculum	Elective
Training hours (this including independent education)	**Total hours-180** **Audience Training hours – 54** Lecture training hour – 28 Practical training hour – 26 **Independent education -126 hours**
ECTS	6
The purpose and tasks of subject / learning outcomes	**The purpose of teaching the subject is** "Solar heat supply systems" – Currently, issues of widespread use of non-traditional and renewable energy sources are being widely discussed all over the world. In order to solve this problem, the task of training qualified basic personnel for bachelors and masters is set in the conditions of the Republic of Uzbekistan. In achieving this goal, such requirements are imposed as having theoretical fundamental knowledge and practical skills, knowing the history of the development of solar heat supply systems, studying the technical potential of solar gross resources, studying the basics of using thermal devices, attending round tables with scientists in the field, scientific seminars. **The objective of the course** "Solar heat supply systems" The main goal of teaching this subject is to provide students with the necessary knowledge about the use of the technical potential of solar energy in our country, the technical and economic indicators of devices, their role in ecology and the principles of use, as well as correct technical problems. To form the skills of accepting various solutions, to study the methods of converting the energy of natural energy and secondary sources into heat energy, to form the skills of drawing up the principle schemes of renewable energy source devices, to determine the power that can be received in the use of solar thermal devices with the help of calculations and formation of skills to use devices. At the same time, it is planned to learn the necessary knowledge and skills to be able to use "Solar heat supply systems" in the natural conditions of the Republic of Uzbekistan. Learning Outcomes: 1. Acquaintance with the basics of solar heat supply systems based on modern types, methods and programs; 2. Role of solar heat supply systems in society and socio-economic importance; 3. Acquaintance with solar heat supply systems; 4. Study of solar heat supply systems using modern computer programs; 5. Studying the technical and economic indicators of solar thermal devices, their place in ecology and the principles of use; 6. Increasing the efficiency of solar heat supply system equipment; 7. Economic assessment of the competitiveness of traditional and non-traditional methods of heat energy production; 8. To know and be able to use the existing main legal and regulatory documents in the field.

Course content (topics)	**I. Main Theoretical Part (Lecture Sessions)** Topics: 1. Introduction to “Solar Thermal Devices and Systems”. 2. The sun and its structure. The nature of solar radiation. Solar radiation on the Earth's surface. Straight, diffuse and global solar radiation. 3. Physical basis of converting solar energy into heat. 4. Heat exchange in the processes of condensation and boiling in heat devices. 5. Radiant heat transfer. Radiation of heat exchange between surfaces. 6. Solar thermal station (STS). Solar thermal power plant based on the Stirling engine. 7. Tower-type solar thermal station. 8. Parabolocylindrical solar thermal devices and supply systems. 9. Solar heat supply system. Flat and vacuum tube solar collectors 10. Solar collectors equipped with concentrators. 11. Basic elements of flat and vacuum solar collectors. 12. Classification of heat accumulators. 13. Use of solar energy in the heating system of rooms. 14. Solar drying devices and systems. Their working process and different constructions. **II. Instructions and recommendations for organizing laboratory exercises.** Laboratory work is not included in the curriculum **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. Review of regulatory documents adopted in the Republic of Uzbekistan in the field of solar energy. 2. To study the methods of calculation of solar radiation flux density directly falling on an optional sloped receiver site. 3. Classification of solar energy devices and their characteristics. Study of tower solar power plants and their energy properties. 4. Study of the system of passive and active solar water heaters. Types of heat carriers and their circulation method. 5. Heliocollector heat balance. Studying the construction of the absorbing (absorbing) panel of the collector. 6. Calculation of the decrease of the mass of the Sun over time according to the results of radiation. 7. Calculation of direct, diffuse and total solar radiation falling on the horizontal surface of the Earth. 8. Calculation of heat transfer coefficients in laminar mode. Dimensionless aggregates used to summarize experimental data on convective heat transfer. 9. Performing practical calculations on determining the effective coefficients of solar radiation transmission, absorption and

	reflection for single-layer transparent coatings. 10. Calculation of flat parabolic concentrator solar power plants. Calculation of the characteristics of the solar heat supply system. 11. Calculation and design of passive solar systems. Calculation and design of active solar systems. 12. Learning the principle of operation of the concentrating solar collector. Learning the principle of operation of a flat solar collector. Calculation of the coefficient of heat loss of the solar collector. 13. Calculation of the heat balance of the flat receiver. **IIV. Independent learning and practical exercises** 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 practical exercises: 1. Single circuit solar collectors. 2. Problems of using renewable energy sources. 3. Autonomous system of providing heat to the facility. 4. Calculation of parameters of heat storage devices. 5. Planning the implementation of solar energy calculations in the modeling program. 6. Alternative and renewable energy sources. 7. Two-circuit solar collectors. 8. Solar heat supply systems for heating buildings. 9. Energy supply of autonomous solar photoelectric systems. 10. Energy distribution in a photoelectric system operating in parallel with the power grid. 11. Prospects for the use of alternative energy fuels in Uzbekistan. 12. Parabolaoid solar oven. 13. Structural systems of solar elements. 14. Thermoelectric generators. 15. Solar power plants based on thermodynamic mode. 16. Use of geothermal energy resources in the greenhouse system. 17. Application of photoelectric systems for energy supply of elevators of high-rise buildings. 18. Regulatory documents adopted in Uzbekistan in the field of solar energy.
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:** 1. Law of the Republic of Uzbekistan "On the use of renewable energy sources" No. ORQ-539, adopted on May 21, 2019. 2. Обухов С. Г Системы генерирования электрической энергии с использованием возобновляемых энергоресурсов // Учебное пособие. Издательство Томского политехнического университета. 2008. – С.140. 3. В.И. Виссирионов, Г.В. Дерюгина, В.А. Кузнецова, Н.К. Малинин Солнечная энергетика Учебное пособие для Вузов.Москва. Издательство МЭИ. 2008. С.-317. 4. Фалеев Д.С Основные характеристики солнечных модулей // Методическая указания. Хабаровск.2013. – ИздательствоДВГУПС. –С.28. 5. Gremenok V.F., Tivanov M. S., Zalesski V.B Solar cells based semiconductor materials// International Scientific Journal for Alternative Energy and Ecology – 2009 – Vol.69. №1. –P. 59-124. 6. Афанасьев В. П., Теруков Е. И., Шерченков А. А Тонкопленочные солнечные элементы на основе кремния // Санкт-Петербург. Издательство СПбГЭТУ «ЛЭТИ» 2011. 7. Андреев В.М, Грилехес В.А, Румянцев В.А. Фотоэлектрическое преобразование концентрированного солнечного излучения. Л.-Наука, 1989. 8. Ляшков В.И, Кузьмин С.Н Нетрадиционные и возобновляемые источники энергии// Учебное пособие для студентов теплоэнергетических специальностей вузов. Издательство ТГТУ –Томбов. 2003. –С.96. **Additional literature:** 9. Mirziyoyev Sh.M. Yangi O‘zbekistonda erkin va farovon yashaylik. –T.: “TASVIR nashriyot uyi”, – 2021.– 50 b. 10. Mirziyoyev Sh.M. Milliy taraqqiyot yo‘limizni qati’yat bilan davom ettirib yangi bosqichga ko‘taramiz .–T.:“O‘zbekiston”, 2017–592 b 11. Decree of the President of the Republic of Uzbekistan dated January 28, 2022 No. PF-60 “On the Development Strategy of New Uzbekistan for 2022-2026”. 12. Decree of the President of the Republic of Uzbekistan No. PF-220 dated 09.09.2022 “On additional measures for the introduction of energy-saving technologies and the development of small-capacity renewable energy sources”. 13. Виссарионов В.И., Дерюгина Г.В., Кузнецова В.А., Малинин Н.К. Солнечная энергетика. Учебное пособие для вузов. – М.: Издательский дом МЭИ, 2008. 14. В.Г.Лабейш. Нетрадиционные и возобновляемые источники энергии: Учеб. пособие. - СПб.: СЗТУ, 2003. 15. Лукутин Б.В. Возобновляемые источники электроэнергии. Учебное пособие. – Томск: Изд. Томского политехнического университета, 2008. 16. Плыкин В.Д. Нетрадиционные возобновляемые источники энергии. Учеб пособие. - Ижевск: Изд. Удмуртский университет, 2013. 17. Аллаев К.Р. Энергетика мира и Узбекистана. Аналитический обзор. – Ташкент: «Молия», 2007 18. Prospects for the development of renewable energy in Uzbekistan. United Nations Development Program (Section 7). – T.: «Media Basim», 2007. 19. Trends and Prospects of Solar Energy Technologies

	Proceedings of the 6th meeting of the Asian Solar Energy Forum – Tashkent. 2013. November 20-23 – P.54. **Internet sites:** 20. www.gov.uz –Government portal of the Republic of Uzbekistan. 21. www.catback.ru – international scientific articles and educational materials website. 22. www.google.ru – international educational materials search website. 23. www.ziyonet.uz – national educational materials search website. 24. www.lex.uz – national database of legal documents and information. 25. www.catback.ru – scientific articles and educational materials.