Name of subject	**Preparation for Operation and Design of Installation of Energy Systems Based on Alternative Energy Sources (ECTS 10)**
Subject/module code	MEMAEQO‘LFT12306
Science taught semester (s).	2nd and 3rd semesters
Responsible teacher	Anarboev Mukhiddin Almanovich, PhD., associate professor.
Education language	Uzbek
Connection to the curriculum	Compulsory
Training hours (this including independent education)	**Total hours-300** **Audience Training hours – 90** Lecture training hour – 46 Practical training hour – 44 **Independent education -210 hours**
ECTS	10
The purpose and tasks of subject / learning outcomes	**The purpose of this course** is to provide students with comprehensive theoretical and practical knowledge required for the planning, installation, and commissioning of energy systems based on alternative energy sources. The course covers a wide range of topics including the classification and reserves of renewable energy sources, principles of thermal and electrical energy generation and utilization, and the technical foundations for the deployment of alternative energy technologies. Students will study the structure and operating principles of devices powered by alternative sources, such as solar energy systems, heat pumps, low-potential energy sources, wind turbines, biogas plants, and geothermal units. The course emphasizes the practical applications of renewable energy systems, focusing on system design, energy accumulation and storage, hybrid operation of conventional and non-conventional sources, and the future prospects of the renewable energy sector. By completing this course, students will be able to develop and evaluate engineering solutions for the integration of renewable energy systems, optimize their performance, and assess their technical and economic viability for use in Uzbekistan’s energy infrastructure. They will also gain awareness of ecological implications and the global shift toward sustainable energy development. **The objective of the course** *“Designing, Installation and Operational Readiness of Energy Systems Based on Alternative Energy Sources”* is to prepare future specialists in the field of renewable energy, focusing on the planning, installation, and commissioning of systems powered by alternative energy sources. Students will acquire comprehensive theoretical knowledge and practical skills related to system design, energy conversion, and integration. The course also covers the structure, operation, and technical characteristics of solar, wind, geothermal, biomass, and hydrogen-based devices. It emphasizes performance analysis, environmental and economic assessment, and system optimization. Additionally, students will participate in seminars and discussions with field experts, enabling them to make responsible, well-informed engineering decisions. **Learning Outcomes:** 1. To acquire knowledge about the planning, installation, and commissioning of energy devices based on alternative energy sources. 2. To study the structure, operating principles, and fundamental concepts of utilizing adapted energy systems. 3. To explore the global development and implementation

	processes of unconventional and renewable energy technologies (URETs). 4. To understand the methods of converting natural and secondary energy sources into thermal and electrical energy. 5. To develop skills in calculating according to assessment parameters of unconventional and renewable energy sources. 6. To build competence in drawing principle circuit diagrams of renewable energy system devices. 7. To develop the ability to determine the extractable power of devices based on renewable energy technologies through calculations and to operate such systems effectively. 8. To assess the feasibility of using renewable energy technologies in the natural conditions of the Republic of Uzbekistan.
Course content (topics)	**I. Main Theoretical Part (Lecture Sessions)** Topics: **2nd semester** 1. Introduction to the course "Planning, Installation and Operational Readiness of Energy Systems Based on Alternative Energy Sources." Basic concepts, terms, and quantities 2. Power supply for decentralized consumers 3. Construction of photovoltaic batteries 4. Electrical safety requirements for photovoltaic batteries 5. Requirements for components of photovoltaic systems 6. Charge-discharge controllers and inverters in photovoltaic systems 7. Replacement, maintenance, and acceptance of devices in decentralized power supply systems 8. Designing a hot water supply system for a household providing 400–600 liters per day **3rd semester** 9. Designing the use of combined solar heating systems and individual boilers for residential heating 10. Planning the construction of a tower-type solar power plant: site selection and analysis of solar tracking systems for heliostats 11. Manufacturing and designing a parabolic-cylindrical type solar thermal power plant 12. Designing wind energy system installations and stations 13. Designing heat pump devices 14. Designing and installing biogas energy systems 15. Developing and designing small and micro hydropower plants **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. Recommended Practical Topics: **2nd semester** 1. Analysis of parameters, characteristics, energy indicators, and other data of energy devices based on alternative and renewable energy sources 2. Study and analysis of power supply issues for decentralized consumers

	3. Design and technical requirements for photovoltaic batteries 4. Electrical safety standards and usage procedures for photovoltaic power stations 5. Requirements and usage procedures for photovoltaic station components 6. Charge-discharge controllers and inverters in photovoltaic systems and design-based calculation tasks 7. Inspection and technical maintenance of decentralized power supply system devices 8. Design calculations for hot water supply systems (400–600 liters/day) for facilities **3rd semester** 9. Design calculations for combined heliosystems and individual gas boilers in heating systems 10. Design calculations for tower-type solar thermal power plants 11. Simulation of the design process of a parabolic-cylindrical type solar thermal power station 12. Design procedures for wind energy systems and stations 13. Design methods for heat pump systems 14. Design and installation of biogas systems and small/micro hydropower plants 15. Study of methods for identifying geothermal resources 16. Design of geothermal systems for heat supply 17. Calculation of dual-circuit geothermal power plants 18. Calculation of single-circuit geothermal power plants 19. Efficiency calculation of hydrogen-oxygen fuel cells 20. Study of electrophysical properties of solar cell batteries 21. Calculation of solar power stations with flat parabolic concentrators **IV. 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: **2nd Semester** 1. Challenges in the Utilization of Renewable Energy Sources 2. Desalination of Water and Air Cooling Using Solar Energy 3. Biological, Chemical, and Mechanical Methods of Energy Storage 4. Efficiency Calculation of Hydrogen-Oxygen Fuel Cells 5. Electrical Safety Requirements and Usage Procedures of Photovoltaic Power Stationss 6. Inspection and Technical Maintenance of Decentralized Power Supply Systems **3rd Semester** 7. Methods for Processing Biomass 8. Types of Energy Obtained from Biomass Processing 9. Global Development of Biogas Technologies and Factors Influencing Biogas Production 10. Design and Installation Processes for Biogas Systems and Small/Micro Hydropower Plants 11. Study of the Electrophysical Properties of Solar Cell Batteries.
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:

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2. Альтернативные источники энергии и энергосбережение : практические конструкции по использованию энергии ветра, солнца, воды, земли, биомассы /
3. В. Германович, А. Турилин. — Санкт-Петербург : Наука и Техника, 2014. — 317 с.
4. Альтернативные топливно-энергетические ресурсы: экономикоуправленческие аспекты использования в условиях инновационного развития общества / В. В. Богатырева и др. — Новополоцк : Полоцкий государственный университет, 2017. — 323 с.
5. Закон Республики Узбекистан «О рациональном использовании энергии» 1997 г.
6. Материалы широкомастабного совместного проекта ПРООН/ГЭФ и Правительства Узбекистана «Повышение эффективности зданий социального назначения в Узбекистане» 2011 г.
7. Постановление Кабинета Министров РУз №164 «Правила проведения энергетичемского аудита и энергетических экспертиз потребителей ТЭР». 07.08.2006 г.
8. Постановление Кабинета Министров Республики Узбекистан № 13 «О мерах по разработке концепции реформирования системы теплоснабжения и программы модернизации и развития системы теплоснабжения в республике на период 2009-2015 годы» 2009 г.
9. КМК 2.01.04-97 Строительная теплотехника. Госкомархитектстрой РУз- Ташкент:1997.
10. КМК 2.04.05-97 Отопление, вентиляция и кондиционирование. Госкомархитектстрой РУз-Ташкент: 1997.
11. КМК 2.08.04-04 Нормативы расхода энергии на отопление, вентиляцию и кондиционирование зданий и сооружений. Госкомархитектстрой РУз-
12. Ташкент:2004
13. КМК 2.01.18-00 Административные здания Госкомархитектстрой РУз- Ташкент:2000.

Additional literature:

14. КМК 2.03.10-95 Крыши и кровли. Госкомархитектстрой РУз-Ташкент: 1995. ШНК 2.08.02-09 Общественные здания и сооружения.

15. Госкомархитектстрой РУз-Ташкент:2009.
16. Здания и сооружения, приспосабливаемые под лечебные учреждения. Госкомархитектстрой РУз-Ташкент: 1997.
17. Богословский В.Н., Поз М.Я.. Теплофизика аппаратов утилизации тепла систем отопления, вентиляции и кондиционирования воздуха. М., Стройиздат, 1983.
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27. Узгосэнергонадзор, 2005.
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Internet sites:

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2. www.catback.ru – international scientific articles and educational materials website.
3. www.google.ru – international educational materials search website.
4. www.ziyonet.uz – national educational materials search website.
5. www.lex.uz – national database of legal documents and information.
6. www.catback.ru – scientific articles and educational materials