| Name of subject | Harvesting energy from alternative energy sources (ECTS 4) |
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| **Subject/module code** | MEMEY2204 |
| Science taught semester (s). | 2nd semester |
| Responsible teacher | Anarboev Mukhiddin Almanovich, PhD associate professor. |
| Education language | Uzbek |
| Connection to the curriculum | Elective |
| Training hours (this including independent education) | **Total hours-120**<br>**Audience Training hours – 36**<br>Lecture training hour – 18<br>Practical training hour – 18<br>**Independent education -84 hours** |
| ECTS | 4 |
| The purpose and tasks of subject / learning outcomes | **The purpose of teaching the subject** is to prepare students for the practical application of theoretical and practical knowledge of the process of installation, design and preparation for operation of energy devices based on alternative energy sources. It also aims to form in them knowledge, skills and qualifications appropriate to the profile of the specialist in the main types, structure, scope of use of devices based on alternative and renewable energy sources and methods of their selection in accordance with specific conditions.<br>The task of the subject is to enable its students to;<br>- Study devices based on alternative, QTEM;<br>- Study the structure, principle of operation, basic principles of use of adapted energy devices;<br>- Study the process of acquiring QTEM of unconventional energy sources on a global scale;<br>- Study the method of converting the energy of natural energy and secondary sources into heat and electricity;<br>- to form the ability to calculate according to unconventional and QTEM evaluation parameters;<br>- to form the ability to draw up principle diagrams of renewable energy source devices;<br>- to determine the power that can be received when using QTEM-based devices using calculations and to form the ability to use devices;<br>- to study the feasibility of using QTEM in the natural conditions of the Republic of Uzbekistan.<br>**The objective of the course** *"Harvesting Energy from Alternative Energy Sources"* is to equip students with a comprehensive understanding of the theoretical foundations and practical applications related to the design, installation, operation, and maintenance of energy systems based on alternative and renewable sources. The course aims to enable students to model and construct equivalent energy systems, analyze performance parameters, and evaluate the efficiency of various unconventional energy technologies (QTEM) under both global and region-specific conditions. Throughout the course, students will examine the structural and functional aspects of photovoltaic, wind, hydro, geothermal, hydrogen, and biogas systems. They will learn to calculate energy outputs, optimize system design for real-world applications, and evaluate sustainability metrics using modern numerical methods and simulation tools. Emphasis will be placed on the technical, environmental, and economic feasibility of integrating such technologies into the power supply infrastructure of Uzbekistan. Additionally, students will analyze the behavior of electric power systems under transient and steady-state conditions, assess the effects of |

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| | overvoltages and discharge phenomena, and study advanced protection mechanisms. The course will prepare students to make informed decisions regarding technology selection, system scaling, and energy conversion strategies in decentralized and centralized power supply contexts.<br>Learning Outcomes:<br>1. Have a clear idea and knowledge of the role of the power supply system in the energy system, saving electricity, and its proper distribution to consumers;<br>2. Know the basic concepts of the field and their essence, initial information on the design of consumer power supply systems, as well as the specific features of the use of traditional and non-traditional energy sources and have the skills to use them;<br>3. Must be able to study and analyze existing problems in the field of uninterrupted and high-quality heat and energy supply to consumers and adopt initial solutions to these problems. |
| Course content (topics) | **I. Main Theoretical Part (Lecture Sessions)**<br>Topics:<br>1. Introduction to the science of designing and preparing for operation the installation of energy devices based on alternative energy sources. Basic concepts, terms and quantities.<br>2. Power supply of decentralized consumers.<br>3. Constructions of photovoltaic cells.<br>4. Electrical safety requirements for photovoltaic batteries.<br>5. Requirements for photovoltaic battery components.<br>6. Charge-discharge controllers and inverters in photovoltaic systems<br>7. Replacement, maintenance and acceptance of devices in decentralized power supply systems.<br>8. Design of hot water supply for a house with a capacity of 400-600 l / day.<br>9. Design of a combined solar system and individual boilers for a house heating system.<br>10.Design of tower-type solar power plant construction, site selection, consideration of solar tracking systems for heliostats.<br>11.Production and design of a parabolic-cylindrical solar thermal power station.<br>12.Design of wind energy plants.<br>13.Design of heat pump devices.<br>14.Design and installation of biogas devices.<br>15.Development and design of small and micro hydroelectric power plants.<br>**II. Instructions and recommendations for organizing laboratory exercises.**<br>Laboratory work is not included in the curriculum<br>**III. Practical training instructions and recommendations**<br>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. Determining parameters of elements and developing equivalent circuits for short-circuit calculations
2. Calculating symmetrical and asymmetrical short-circuit conditions using various methods
3. Calculating and analyzing the static stability of an electric power system
4. Analyzing the dynamic stability of an electric power system
5. Characteristics of the electric field
6. Electrical insulation materials
7. Power supply and distribution equipment
8. Solving problems related to breakdown, flashover, and discharge voltages in dielectrics
9. Protection of system elements against direct lightning strikes
10. Solving problems related to the selection of lightning arresters and grounding resistance
11. Selection of surge arresters
12. Solving problems related to atmospheric and internal overvoltages and the use of surge arresters for protection
13. Solving problems related to the lightning resistance of overhead transmission lines
14. Examination of visible corona discharge on conductors of overhead transmission lines
15. Study of voltage distribution along suspension insulator strings

**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. Analysis of parameters, characteristics and energy indicators of energy devices based on alternative and renewable energy sources and other data.
2. Study and analysis of issues of power supply of unmarked consumers.
3. Constructions of photovoltaic batteries and requirements for them.
4. Requirements for electrical safety of photovoltaic stations and procedures for their use.
5. Requirements for components of photovoltaic stations and procedures for their use.
6. Charge-discharge controllers and inventories in photovoltaic systems and calculations for their design.
7. Inspection and maintenance of devices of decentralized power supply systems.
8. Calculations for the design of hot water supply of 400-600 l / day for hot water supply of facilities.
9. Design calculations for the use of combined solar systems and individual gas boilers for heating systems.
10. Design calculations for the construction of tower-type solar thermal power plants.
11. Modeling the design processes of a parabolic trough solar thermal power plant.
12. Design procedures for wind energy installations and stations.
13. Design methods for heat pump installations.
14. Design and installation of biogas installations.
15. Design processes for small and micro hydroelectric power

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| | plants.<br>16. Study of the methodology for determining geothermal resources<br>17. Study of the design of a geothermal system providing heat<br>18. Calculation of two-circuit geothermal power plants<br>19. Calculation of one-circuit geothermal power plants<br>20. Calculation of the FIC of a hydrogen-oxygen fuel cell<br>21. Study of the electrophysical properties of a solar cell battery<br>22. Calculation of solar power plants with a flat parabolic concentrator<br>Practical classes are conducted by one professor per academic group in an auditorium equipped with multimedia devices. Classes are conducted using active and interactive methods, and it is desirable to arouse interest in the requirements for the possibilities of deepening knowledge through the use of appropriate pedagogical and information technologies, to provide the opportunity to independently achieve the result, and to prepare theoretically and methodologically. |
| 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.<br>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.<br>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.<br>The teacher who taught the students in this discipline is not involved in the process of conducting the exam and checking the students' answers.<br>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<br>Purpose: Determining and assessing the student's level of knowledge, practical skills, and competencies on course topics.<br>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.<br>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.<br>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 |
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| 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 |

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| | | | 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 |
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| 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. Twidell J.W., Wier A.D. Renewable Energy Resources. London, 2015.
2. Gemma Herranz, Gloria P.Rodrnguez. Uses of Concentrated Solar Energy in Materials Science.-Spain; INTECH, 2010. ISBN 978-953-307-052-0
3. S.A.Nikonov, A.A Goryayev, S.V Petuxov, N.B. Balanseva, S.V Butakuv. Netraditsionnie istochniki energii v agropromishlennom komplekse. Metodicheskiye ukazaniya dlya provedenya prakticheskix zanyatiy. Novosibrsk-2018.
4. Ellabban Omar, Abu-Rub Haitham, Blaabjerg Frede. Renewable energy resources; Current status, future prospects and their enabling technology. Renewable and Sustainable Energy Reviews, 2014.
5. Majidov I. Noan'anaviy va qayta tiklanuvchi energiya manbalari-T.. Vopris nashryoti-2014.
6. Kichev SH.I., Muxammadiyev M.M., Avezov R.R., Potoyenko K.D. Nyetraditsionnie I vzobnovlyayemi istochniki energii. Uchebnik. T.. Izd-vo Fan va texnologiya-2010.
7. Muxammadiyev M.M., Tashmatov X.K. Energiya yig'uvchi qurilmalari. Darslik.-T.. Yangi nashr-2010.

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**Additional literature:**

9. O'zbekistonda qayta tiklanadigan energetikani rivojlantirish istiqbollari. BMT Taraqqiyot dasturi.-T., 2007y.

10.Nicola Armaroli, Vincenzo Balzani. Energy for a Sustainable Word-Form the Oil Age to a Sun-Powerd Future. Wiley-VCH 2011. ISBN 978-3-527-32540-5.

11.Lovins, Amory, Reinventing Fire; Bold Business Solutions for the New Energy Era. Chelsea Green Publishing, 2011.

12.Volker Quaschning. Understanding Renewable Energy System. Warthscan, London, 2016. ISBN 978-113878-196-2.

13.Global Trends in Renewable Energy Investment 2016. Frankfurt School-UNEP Center/BNEF. 2016. http;//www.fs-unep-center.org..

14.Word Energy Council. For sustainable energy. Copyright 2013 World Energy Council, London, www.worldenergy.org. ISBN; 978-0-946121-29-8.Vissarionov V.I., Deryugina G.V., Kuznetsova V.A., Malinin N.K., Solnechnaya energetika. Uchebnoye posobiye dlya vuzov.-M; Izdatelskiy dom MEI, 2008.

15.Kukutin B.V. Vozobnovlyayemie istochniki elektroenergii. Uchebnoye posobiye.- Tomsk; Izd. Tomskogo politexnicheskogo universiteta, 2008.

16.Muxammadiev M.M., Urishev B.U., Djuraev K.S., Gidroenergetik qurilmalar. Darslik.- Toshkent; Fan va texnologiya-2015.

**Internet sites:**

17. www.gov.uz –Government portal of the Republic of Uzbekistan.

18. www.catback.ru – international scientific articles and educational materials website.

19. www.google.ru – international educational materials search website.

20. www.ziyonet.uz – national educational materials search website.

21. www.lex.uz – national database of legal documents and information.

22. www.catback.ru – scientific articles and educational materials.