



Co-funded by the
European Union

DEBSEUz

MINISTRY OF HIGHER EDUCATION, SCIENCE AND INNOVATION
OF THE REPUBLIC OF UZBEKISTAN



FARG'ONA
DAVLAT
TEKNIKA
UNIVERSITATI



«APPROVED»

Recto
Vice Rector for Academic Affairs

J.J.Jakhongirov

08
2025-year

SCIENTIFIC AND PRACTICAL RESEARCH CENTER FOR
RESEARCHING RENEWABLE ENERGY SOURCES PROBLEMS AT
FERGANA STATE TECHNICAL UNIVERSITY

DEPARTMENT OF “Electronics and Instrumentation”

SYLLABUS

FOR A PROFESSIONAL TRAINING COURSE ON
SOLAR ENERGY ENGINEERING

The syllabus was approved by the protocol No. ____ of the Scientific and Methodological Council of Fergana State Technical University

“ ____ ” _____.

Editors:

A.A. Kuchkarov - Head of the Department of “Electronics and Instrumentation”, PhD., Associate Professor.

Reviewers:

S.F. Ergashev - DSc., Professor of the Department of “Electronics and Instrumentation”.

N.R. Avezova - “DSc., Professor of the Department of “Electronics and Instrumentation”.

Head of the Department
of “Electronics and Instrumentation”
2025-yil “ ____ ” ____



(signature) A.A. Kuchkarov

Head of the Educational and
Methodological Department
2025-year



(signature) G.I. Mamatisaev

Dean of the Faculty of
Power Engineering
2025-year



(signature) M.O. Uzbekov

(The syllabus was discussed and approved at the department's meeting No. ____
on “ ____ ” _____, 2025).

(The syllabus was discussed and approved at the faculty meeting No. ____ on
“ ____ ” _____, 2025).

Course information

Program authors:	A.A.Kuchkarov
E-mail:	info@fstu.uz
Phone number:	+998916624102
Affiliation:	Fergana State Technical University, Department of “Electronics and Instrumentation”
Information about professors and teachers	Lecturer: A.A. Kuchkarov. PhD, Associate Professor
	Lecturer: N.R.Avezova. DSc, Professor
	Lecturer: S.F.Ergashev. DSc, Professor
	Lecturer: M.O.Uzbekov. PhD, Associate Professor
	Lecturer: O.M.Mamatov. PhD, Associate Professor
	Lecturer: B.A.Abdukarimov. PhD, Associate Professor
	Lecturer: B.B.Boynazarov. PhD, Associate Professor
	Practitioner: A.A.Quchqarov. PhD, Associate Professor
	Practitioner: B.A.Abdukarimov. PhD, Associate Professor
	Practitioner: B.B.Boynazarov. PhD, Associate Professor
Practitioner: O.M.Urishev. PhD, senior teacher	

Total course hours – 30 hours

Lecture training	Practical training	Laboratory training	Total
14	10	6	30

1. The goal of science

The primary goal of science within this training course is to develop a systematic, evidence-based understanding of renewable energy sources and their technological, environmental, and socioeconomic implications. This program aims to equip participants with the ability to critically analyze modern renewable energy systems, identify the fundamental physical principles governing their operation, and apply scientific methods to evaluate performance, efficiency, and long-term sustainability.

The course seeks to strengthen research-oriented thinking by fostering the ability to design experiments, interpret empirical data, and model energy processes using contemporary analytical tools. A key scientific objective is to bridge theoretical knowledge with practical applications, enabling learners to solve real-world challenges related to resource assessment, system optimization, energy conversion efficiency, and integration of renewable technologies into existing energy infrastructures.

In addition, the course promotes the advancement of innovative ideas and encourages scientific inquiry into emerging trends such as smart energy systems, bifacial photovoltaic technologies, hybrid renewable systems, and climate-adaptive energy solutions. By supporting rigorous investigation and interdisciplinary collaboration, the program aspires to contribute to the sustainable development agenda and to prepare specialists capable of leading research and technological innovation in the renewable energy sector.

The training course provides theoretical and practical knowledge in the following 5 subjects: “Solar thermal devices and systems”, “Optical and physical properties of semiconductor materials”, “Generation, transmission and distribution of electricity”, “Design of energy devices and stations based on alternative energy sources”, “Energy storage methods and devices”.

Goals and objectives of science. The overarching goal of science in this training program is to establish a strong theoretical and experimental foundation for understanding, analyzing, and developing modern renewable energy technologies. This includes fostering scientific thinking, advancing research capabilities, and promoting innovation across key areas such as solar thermal systems, semiconductor materials, electrical energy infrastructures, alternative power plant design, and advanced energy storage technologies.

The program aims to create a scientifically literate and research-oriented community of students, specialists, and researchers capable of contributing to the sustainable transformation of the global energy sector.

Objectives of Science. To achieve these goals, the scientific objectives of the course include:

1. Understanding Fundamental Principles

Develop a deep, systematic understanding of the physical, optical, thermal, and electrical principles that govern renewable energy devices and systems.

2. Analyzing Solar Thermal and Semiconductor Processes

Investigate the scientific mechanisms of solar thermal conversion and evaluate the optical/electronic behavior of semiconductor materials used in modern energy technologies.

3. Studying Power Generation and Distribution

Explore the scientific foundations of electricity generation, transmission, and distribution, with emphasis on efficiency, reliability, and grid integration of renewable sources.

4. Designing Alternative Energy Systems

Apply scientific and engineering principles to the conceptualization, modeling, and optimization of devices, stations, and infrastructures based on alternative energy sources.

5. Examining Energy Storage Technologies

Understand and evaluate advanced energy storage mechanisms, including thermal, electrochemical, mechanical, and hybrid systems.

6. Developing Experimental Competencies

Utilize modern laboratory equipment to perform precise measurements, characterize device performance, and validate theoretical models through experimental methods.

7. Enhancing Analytical and Research Skills

Strengthen skills in data analysis, scientific modeling, simulation techniques, and interpretation of experimental results.

8. Encouraging Innovation and Problem-Solving

Foster creativity and innovation to address real-world challenges related to energy efficiency, system reliability, and sustainable technology deployment.

9. Promoting Interdisciplinary Collaboration

Integrate knowledge across physics, materials science, electrical engineering, and energy technology to support interdisciplinary research and system-level problem-solving.

10. Preparing Professionals for Advanced Research and Practice

Equip participants with the scientific tools and competencies needed to pursue advanced research, academic inquiry, or professional work in the renewable energy sector.

Scientific module topics for “Solar thermal devices and systems”

№	Lecture session	Hours
1.	Solar collector typologies and definition of efficiency. Thermal balance of a solar collector and analysis of temperature profile of the plate. Hottel equation. Thermal and optical characterization of plate, glazed cover, ducts, and insulation. Economic benefits and cost analysis	2
2.	Passive solar heating systems: Fundamentals of passive Solar heating; Design Strategies for passive Solar heating; Key components of passive Solar design; Types of passive Solar heating systems; Economic benefits and cost analysis	2
	Practical session	
	Convective heat transfer during flow in pipes and channels. Convective heat transfer under forced convection conditions. Heat and mass transfer processes in solar water heaters. Methods for optimizing the thermal, geometric, optical characteristics of the main components of solar water heaters. Heat and mass transfer processes in solar dryers. Natural and forced convection processes in solar dryers.	2
Total		6

Scientific module topics for “Optical and physical properties of semiconductor materials”

№	Lecture session	Hours
1	Contact phenomena: metal–semiconductor contact, p-n junctions, heterojunctions. Optical properties of semiconductors: absorption and reflection spectra, excitons. Optical and photoelectric devices	2
	Practical session	
1	Optical properties of semiconductors: absorption and reflection spectra, excitons. Photoelectric phenomena: photoconductivity, photovoltaic effects, Schottky barrier. Optical and photoelectric devices: LEDs, semiconductor lasers, photodiodes, phototransistors	2
	Laboratory session	
1	Luminescence in semiconductors: types, mechanisms, spontaneous and stimulated emission. Optical properties of semiconductors: absorption and reflection spectra, excitons. Optical and photoelectric devices: LEDs, semiconductor lasers, photodiodes, phototransistors.	2
Total		6

Scientific module topics for “Generation, transmission and distribution of electricity”

№	Lecture session	Hours
1	Alternative energy sources: types and main characteristics. Transmission of electricity generated from alternative energy sources.	2
2	Integration of alternative energy sources in power grids. Smart Grid and alternative energy.	2
	Practical session	
1	Modeling the process of transmitting electricity to consumers in alternative energy systems. Calculation of the connection possibilities of alternative energy sources in electrical networks.	2
Total		6

Scientific module topics for “Design of energy devices and stations based on alternative energy sources”

№	Lecture session	Hours
1	Selection of site and shadow analysis. Selection of PV module (cells and BOM) and sizing. Selection and sizing of Aux. transformer and Aux. Losses calculation. Calculating the Energy Yield for a PV Grid-Connected System. Troubleshooting. Costing and tendering of solar power plant.	2
	Practical session	
1	Calculation of Protective Angles and Zone of Protection for Various. Specific Yield and Performance Ratio.	2
	Laboratory session	
1	Calculation and design of a solar power plant for a given region. Designing a small wind farm. Designing hybrid power plants	2
Total		6

Scientific module topics for “Energy storage methods and devices”

№	Lecture session	Hours
1	Forms of energy accumulation. Heat energy storage systems. Energy accumulation using hydraulic accumulation power plants. Inductive energy storage systems. Current and future opportunities for electricity storage system.	2
	Practical session	
1	Modeling of energy storage systems using MATLAB and Simulink. Design of heat storage systems. Analysis of experiments on latent heat-insulating materials	2
	Laboratory session	
1	Laboratory analysis of the hydrogen production and storage system. Measurement and analysis of the parameters of mechanical energy storage systems. Analysis of the operating condition of hydraulic accumulation power plants.	2
Total		6

Education strategy

Teaching Approach

The course employs a **student-centered and practice-oriented** approach that integrates theoretical concepts with hands-on experience. The main focus is on understanding the working principles, design, and performance evaluation of solar thermal systems through lectures, laboratory experiments, and applied projects.

Teaching Methods

- **Lectures and multimedia presentations:** to deliver core theoretical knowledge about solar energy conversion, collectors, and system design.
- **Practical and laboratory sessions:** to develop experimental and analytical skills in measuring, testing, and evaluating solar thermal devices.
- **Problem-based learning (PBL):** students will solve real-world problems related to solar thermal system design and optimization.
- **Simulation and software tools:** use of TRNSYS, MATLAB, or similar tools for modeling and performance prediction of solar systems.
- **Group discussions and case studies:** to promote teamwork and critical thinking on renewable energy challenges.
- **Independent study and research assignments:** to enhance students' ability to apply theoretical knowledge to practical engineering contexts.

Learning Environment

The learning process takes place in a blended environment combining classroom instruction, laboratory work, and field observation at solar installations. Students will have access to modern measuring instruments, data acquisition systems, and simulation software to support interactive and applied learning.

Student Engagement

Active participation is encouraged through:

- Team-based projects and prototype design.
- Practical demonstrations and energy audit tasks.
- Discussions on innovative technologies and sustainability in solar energy.
- Peer review and presentation of experimental results.

Assessment Strategy

Assessment is continuous and diversified, including:

- **Written tests and quizzes** on theoretical understanding.
- **Laboratory reports and practical performance evaluations.**
- **Project design and presentation** on selected solar thermal applications.
- **Final examination** assessing comprehensive course outcomes.

Expected Outcomes

By the end of the course, students will be able to:

- Understand the principles and operation of solar thermal devices.
- Design and analyze solar heating, drying, and water-heating systems.
- Conduct experimental research and interpret performance data.
- Apply optimization methods to improve system efficiency.
- Evaluate the economic and environmental impacts of solar technologies.

Literature used during the course

Main literature

1. David Lindsley, John Grist and Don Parker. Thermal Power Plant Control and Instrumentation The control of boilers and HRSGs 02nd Edition 2018. P.350.
2. S.F. Ergashev, O.Kh. Kuldashov, U.Zh. Nigmatov. Combined solar power plants for industrial, municipal and agricultural purposes. 2019.
3. Bekirov E.A., Voskresenskaya S.N., Khimich A.P. Calculation of an autonomous power supply system using photoelectric converters. Simferopol: NAPKS, 2010.
4. I. Kh. Siddikov, H. A. Sattarov, O. I. Siddikov, K. E. Khojamatov, D. T. Khasanov, SH. B. Olimova. Modern energy conversion systems. TDAT Publishing House, Tashkent, 2018.
5. K. Allaev. Modern energy and prospects for its development. Toshkent, 2021.
6. L. Tursunov. Bioenergy: Principles and Technologies. Tashkent, 2017.
7. N. Usmanov. Wind Energy Systems and Applications. Tashkent, 2020.
8. T. N. Petrova, "Solar energy in the world: trends and prospects", Energy and Ecology, vol. 14, No. 3, pp. 56-62, 2021.
9. M. G. Smirnov, Solar Power plants: design and operation, Energy Publishing House, 2023.
10. S. V. Lebedev, Solar Energy: Technologies and applications, Nauka Publishing House, 2022.
11. I. Dincer, M.A. Rosen, "Thermal Energy Storage Systems and Applications", John Wiley & Sons, 2nd Edition, 2011.
12. R. Schloegl (ed), Chemical Energy Storage, De Gruyter, 2013.

Additional literature:

1. Mukund R.Patel. Wind and Solar Power Systems: Design, Analysis and Operation. CRC Press. 2021.
2. A. Nina Fathima. Hybrid-Renewable Energy systems in Microgrids: Integration, Developments and Control. USA. 2018.
3. Lange P.K. Physics of Semiconductors and Nanotechnology. Samara STU, 2017.
4. Filippov V.V., Mitsuk S.V. Physics of Semiconductor Devices. Lipetsk GPU, 2016.
5. A.N.Rasulov va boshqalar, «Sanoat korxonalarining elektr ta'minoti» Darslik., -Toshkent: Sano-standart. 2019 y. 5513/4.
6. Magomedov A.M. Renewable energy sources Laboratory workshop. – Makhachkala CPI DSU. 2005. pp 213.
7. Deutsche Gesellschaft für Sonnenenergie (DGS). Planning and Installing Photovoltaic Systems. A Guide for Installers, Architects and Engineers.
8. G.N. Tiwari. Solar energy-Fundamentals, design, modeling and applications, Narosa published. 2005.
9. Butt, H. J., Graf, K., & Kappl, M. Physics and chemistry of interfaces. John Wiley & Sons, 2013.
10. Callen, H. B. Thermodynamics and an Introduction to Thermostatistics, 1998.

Electronic resources

1. www.gov.uz
2. www.lex.uz
3. <https://www.irena.org/>
4. <https://www.renewableenergyworld.com/#gref>
5. <https://www.energy.gov/eere/renewable-energy>
6. <https://www.ren21.net/>
7. <http://www.unwater.org/publications/worldwaterdevelopmentreport/en/>
8. <https://www.iea-shc.org/speakers>

