Name of subject	**Electrical Networks and Systems (ECTS 8)**
Subject/module code	ETT24508
Science taught semester (s).	4th and 5th semesters
Responsible teacher	Abdullaev Elnur Akhmatovich (PhD), associate professor.
Education language	Uzbek
Connection to the curriculum	Elective
Training hours (this including independent education)	**Total hours-240** **Audience Training hours - 96** Lecture training hour – 48 Laboratory training hour – 24 Practical training hour – 24 **Independent education -144 hours**
ECTS	8
The purpose and tasks of subject / learning outcomes	**The purpose of teaching the subject** is to teach students the parameters and conditions of electrical networks, master the methods of calculating and analyzing the conditions of electrical networks and systems, teach the basics of designing the development of electrical systems, teach measures to increase the economy of electrical networks, and familiarize them with the structural and mechanical parts of overhead power lines and teach the basics of their calculation. **The task of the subject** is to teach students how to construct switching schemes for elements of electrical networks and determine their parameters, calculate the electrical states of open and closed electrical networks of varying complexity, characterize the operating states of electrical networks and systems and their assessment, control and adjustment in electrical networks and systems; design electrical networks, and the main criteria for improving and ensuring the efficiency of electrical networks. **Learning outcomes:** 1. Study the history and prospects of the development of the electric power system. 2. Get acquainted with the role and socio-economic significance of electric power in society. 3. Study the state policy of the energy sector and its development trends and prospects in the country and the world. 4. Study the basic concepts and principles in the field of energy networks and systems. 5. Economic assessment of the competitiveness of traditional and unconventional methods of electricity generation. 6. Get a complete picture of the equipment and devices of electric networks and systems. 7. Gain knowledge and skills in the design of electric networks.
Course content (topics)	**I. Main Theoretical Part (Lecture Sessions)** **Topic 1:** Goals and objectives of science. System of accepted basic definitions. The role of energy networks and systems in the transition of the Republic of Uzbekistan to a "green" economy **Topic 2:** Structure of power lines. General information about overhead lines. Wires and cables of overhead lines. Supports of overhead lines. Function of all-important equipment in power distribution networks. **Topic 3:** Insulators and line fittings. Cable structure and cable lines. **Topic 4:** Switching schemes and calculation parameters of power transmission lines. Determination of comparative parameters of power transmission lines. Estimation and modeling of parameters

	Topic 5: Two-winding transformer replacement diagram, catalog and calculation parameters **Topic 6:** Three-winding transformer switching diagram, catalog and calculation parameters. Autotransformer switching diagram, catalog and calculation parameters. Characteristic characteristics of the autotransformer. Nominal and type capacities of the autotransformer. **Topic 7:** Consumer loads. Static characteristics of consumer loads. Categories of consumers. Basic aspects of design and measurement of electrical systems **Topic 8**. Calculation of the state of the power transmission line given the load current and voltage. Vector diagram of the power transmission line current and voltage. Simplified methods for calculating voltage **Topic 9:** Calculation of the electricity transmission network state when the load power and voltage are given. Calculation of the electricity transmission network state when the load power and source voltage are given. Two-stage method. Calculation of the open network states consisting of several electricity transmission networks connected in series and with known load powers. **Topic 10:** Three-winding transformers. Switching diagram and its parameters. Transformers with separate windings. **Topic 11:** Calculation of power flows in simple closed electrical networks with and without losses. **Topic 12:** Calculation of power and voltage distribution in networks supplied from both sides. Calculation of power flows in networks supplied from both sides, taking into account losses. Calculation of voltage distribution in networks supplied from both sides. **Topic 13:** The importance of ensuring active power balance in the electrical system. Frequency deviation and oscillation in the electrical system. Permissible frequency deviation value. Frequency adjustment in turbines. Automatic frequency unloader. Frequency adjustment in the electrical system. **Topic 14:** Reactive power balance in the electrical system and its relationship to voltage. Load balancing effect. Reactive power consumers. Ensuring reactive power balance in network design. **Topic 15:** Tasks of reactive power compensation in the electrical network. The effect of reactive power compensation on energy and voltage losses. Reactive power compensators**.** **Topic 16:** Application of a systems approach and optimization in reactive power compensation. Advantages and disadvantages of a capacitor bank as a compensator. Reactive power generated by a capacitor bank. Advantages and disadvantages of reactors as compensators. Static sources of reactive power**.** **Topic 17:** Quality indicators of electric energy. Normalized values of voltage deviation. The impact of quality indicators of electric energy on the effective operation of the network and consumers. Technological damage caused by violations of quality indicators of electric energy. **Topic 18:** Three-winding transformer switching diagram, catalog and calculation parameters. Autotransformer switching diagram, catalog and calculation parameters. Characteristic characteristics of the autotransformer. Nominal and type capacities of the autotransformer. **Topic 19:** Voltage stabilization, single-phase and multi-phase regulation. Local and centralized voltage regulation. Reverse voltage regulation. Voltage regulation in power plants. **Topic 20:** Voltage regulation using a automatic adjustment of the excitation transformer. Voltage regulation using a adjust under load transformer. Schemes and principles of operation of automatic adjustment of the excitation and adjust under load devices. Voltage regulation using line rectifier transformers.

Topic 21: Adjusting the voltage by changing the network resistance. Determining the resistance of the longitudinal compensation device required to adjust the voltage. Adjusting the voltage by changing the reactive power flow.

Topic 22: Methods of designing an electric network. Main technical and economic indicators. Issues of designing the development of an electric network. Main technical and economic indicators. Selection of the nominal voltage of an electric network.

Topic 23: Compare electricity network options in terms of capital investment and additional costs. Compare electricity network options in terms of costs incurred. Consider the level of reliability when comparing options. Select the nominal voltage when designing an electricity network.

Topic 24: Selection of cross-sectional areas of conductors according to economic current density. The concept of economic current density. Advantages and disadvantages of the method.

II. Instructions and recommendations for organizing laboratory exercises.

In laboratory exercises, students develop practical skills and competencies in various indicators of processes in electrical networks and systems, conducting experiments, calculating and drawing tables and graphs. The recommended topics are selected based on opportunities and conditions.

Recommended topics for laboratory work:

1. Study of normal states of an electrical system. Creation of models for electrical equipment.
2. Study of operating conditions of long power lines.
3. Calculation of the normal state of an electrical network using the Gauss-Seidel method.
4. Calculation of the normal state of an electrical network using the Newton-Raphson method.
5. Reactive power compensation in electrical networks
6. Adjusting voltage in electrical networks by changing the transformation coefficient of transformers
7. Adjusting voltage in electrical networks by changing the resistance of the electrical network.
8. Adjusting the voltage in electrical networks by changing the reactive power of the electrical network.
9. Reducing waste in electrical networks.
10. Increasing the efficiency of electrical network operations.

III. Practical training instructions and recommendations

The teacher's preparation for a practical training session begins with the study of preliminary documents (curriculum, thematic plan, etc.) and ends with the development of a lesson plan. The teacher should have an idea of the goals and objectives of the practical training session, the amount of work that each student must perform.

Methodological guidelines are the main methodological document of the teacher in preparing and conducting practical training sessions.

The purpose of the practical training session is to understand the theory, acquire skills. It is to consciously apply it in educational and professional activities, and to develop the ability to confidently form one's own point of view.

The following topics are recommended for practical training:

1. Construction of equivalent circuit diagrams of electricity transmission network and two-winding transformers and finding calculation parameters.
2. Construct equivalent circuit diagrams of three-phase transformers and autotransformers and find calculation parameters.

	3. Calculation of open electrical network conditions 4. Calculation of the electricity transmission network state with known load power (current) and voltage at the end. Calculation of the electricity transmission network state with known load power (current) and voltage at the beginning. 5. Calculation of open electrical network conditions with known load capacities and voltage at the supply node. 6. Voltage regulation at step-down substations. 7. Choosing the nominal voltage of the electrical network. 8. Selection of the cross-section of the electricity transmission network conductor based on economic current density, economic intervals, and permissible voltage modes. 9. Calculation of power and energy waste in electricity transmission network. 10. Calculation of power and energy losses in the line based on the load graph. 11. Determining power and energy losses in a transformer based on load graphs. 12. Measures to reduce power and energy waste in electrical networks. **IV. Coursework instructions and recommendations** The following topics are recommended for the course project: 1. Design of the power transmission scheme of the hydroelectric power plant. 2. Design of the power transmission scheme of the thermal power plant. 3. Design of the power transmission scheme of the thermal power center. **V. Independent learning and independent work.** Independent learning competence serves to support students' independent self-development and increase the effectiveness of professional activities. Students perform independent work on their mobile devices under the guidance of a teacher in a traditional or electronic form. **Recommended topics for independent study:** 1. Calculation and analysis of highly complex electrical network conditions. 2. Circular vector diagrams of power transmission line parameters. 3. Calculation of the distribution of power flows in homogeneous closed electrical networks by dividing them into circuits. 4. Electrical load graphs. 5. Construction of equivalent circuit diagrams of EUL and transformers and finding calculation parameters. 6. Calculation of electrical network conditions. 7. Simple and complicated substances and importance. 8. Power and energy waste in electrical networks. 9. Reactive power compensation in electrical networks. 10. Selection of power line conductors. 11. Modeling operating conditions of electrical networks using computer programs, developing practical skills.
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. Elektr tarmoqlari va tizimlari: O‘quv qo‘llanma/ A.M. Safarov, T.Sh. G‘oyibov, A.X. Sulliyev. O‘zbekiston Respublakasi Oliy va o‘rta maxsus ta’lim vazirligi. Toshkent. Tafakkur bo‘stoni. 2013.-224 b.

2. Gayibov T.Sh. Elektr tarmoqlari va tizimlari. O‘quv qo‘llanma. – T.: «Voris-nashriyot». 2010.

3. T.Sh. Gayibov., B.M. Pulatov., A.E. Shanazarov. “Elektr tarmoqlari va tizimlari. Misol va masalalar to‘plami”. O‘quv qo‘llanma. –Toshkent., ToshDTU, 2021-175 b.

4. T.Sh. Gayibov, H.F. Shamsutdinov, B.M. Pulatov Elektr tarmoqlari va tizimlari fanidan kurs loyihasini bajarish uchun uslubiy qo‘llanma. – Toshkent: ToshDTU, 2015-57 b.

5. Electric Power Systems/ B.M.Weedy, B.J.Cory, N.Jenkins, J.B.Ekanayake, G.Strbac.- 5th ed., UK, A John Wiley and Sons, 2012.

6. Duncan Glover, Mulucutla s. Sarma, Thomas J. Overbye. Power System Analysis and Design/Fifth edetion.- Australia, Brazil, Japan, United Kingdom, USA. CANGAGE Learning. 2010.

7. Arthur R. Bergen/ Power Systems Analysis / 2000.

8. Elektr tarmoqlari va sistemalari: uslubiy qo‘llanma/ O‘zR OO‘MTV; Rasulov A.N., Taslimov A.D., Mamarasulova F.S., Raxmonov I.U.– Toshkent: TDTU, 2014.- 90 b.

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

3. 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”.

4. 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. Лыпкин А.В. Электрические системы и сети (Электронный ресурс): (учеб. пособ.)– Новосибирск: Изд-во НГТУ, 2002.-248 с

14. Электрические системы и сети. Буслова Н.В., Винославский В.Н., Данисенко Т.И., Перхач В.С. Под ред. Данисенко Г. – Киев: Высшая школа, 2006.

15. Блок В.М. Электрические сети и системы. Высшая школа, 2006.

Internet resources:

16. www.lex.uz – National database of information on legal documents of the Republic of Uzbekistan.

17. www.ziyonet.uz – national educational materials search site.

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

	19. www.google.com – international educational materials search site. 20. www.energystrategy.ru – “Energy Policy and Strategy” information portal 21. www.twirpx.com – international educational materials search site.