Name of subject	Theoretical Electrical Engineering (ECTS 9)
Subject/module code	NAZEL 13409
Science taught semester (s).	3th and 4th semester
Responsible teacher	Nurullayev Orziqul Ubayevich (PhD), head teacher.
Education language	Uzbek
Study to the program connection	Compulsory
Training hours (this including independent education)	**Total hours-270.** **Audience Training hours - 108.** Lecture training hour – 48 Laboratory training hour – 30 Practical training hour – 30 **Independent education -162 hours**
ECTS	9
The purpose and tasks of subject / learning outcomes	**The purpose of teaching** the subject The goal of teaching science is to solve the problem of preparing future specialists, including the electromagnetic field, a form of matter, and the processes that occur in its various devices, methods of analysis, synthesis, and calculation of electric and magnetic fields. **The task of the subject** The task of the subject is to teach students the theory of electrical circuits and their analysis and synthesis. The task of the subject "Theoretical Electrical Engineering" is to teach its students: -elements of electrical circuits and their basic concepts -basic laws and calculation methods for the analysis of constant and alternating current circuits; -resonance phenomena, self-inductance and mutual inductance; -three-phase circuits, periodic non-sinusoidal currents in electrical circuits; -transient processes in linear electrical circuits; -basic laws and calculation methods for quadrupoles, electrical filters, circuits with scattered parameters; -the theory of nonlinear electrical circuits; -the theory of electromagnetic fields is aimed at mastering their analysis and synthesis **Learning outcomes:** 1. Constant current linear electric circuits and methods for their calculation are studied. 2. Electric current. Current density. Ohm's law. Electric energy and electric power. Formulation of topological equations of complex electric circuits based on Kirchhoff's laws. Equivalent transformation of circuits consisting of series, parallel and mixed connected elements 3. Single-phase sinusoidal current linear electric circuits are studied, they get acquainted with the effective and average values of sinusoidal current and learn to calculate them. 4. Three-phase circuits. They can explain the difference between three-phase electric circuits and 5. Non-sinusoidal periodic quantities. Non-sinusoidal current circuits. The concept of non-sinusoidal current. Fourier series. Transient processes in electric circuits. The concept of transient processes. Switching laws. Filters 6. Calculation of transient processes in nonlinear circuits. Electrostatic field. Image method. Capacitance absorption. Calculation of the electric field of a constant current. Calculation of the magnetic field of a constant current

Course content (topics)	**I. Main theoretical part (Lecture)** **Topic 1:** Introduction to the subject of "Theoretical Electrical Engineering".The role and importance of theoretical electrical engineering in modern science and technology and in production. **Topic 2:** Understanding electrical circuits and elements. Resistive, capacitive and inductive elements. Ohm's law. Law of electromagnetic induction. Voltage and current sources. Circuit and its topological forms. Calculation of resistance, capacitance and impedance of inductive circuit elements in alternating current circuits. **Topic 3:**Methods for calculating electrical circuits. Kirchhoff's laws. Calculation of simple electrical circuits. Circuits with elements connected in series, parallel and mixed. Calculation of complex electrical circuits. Methods of contour currents and node potentials. First-order circuits with a resistor and a capacitor connected to a current-voltage generator, determination of current or voltage during charging/discharging using a first-order differential equation . **Topic 4:** Sinusoidal current electrical circuits. Concept of sinusoidal current generation and electrical generators. Concepts of frequency, period, phase, initial phase and amplitude. Current voltage, effective (acting) and average values of e.u.k. Power in AC circuits, S, P and Q, current power, active and reactive average power, RMS value, apparent power, power factor **Topic 5:** Representation of sinusoidal currents and voltages with vectors and complex numbers.Power. Currents and voltages in circuits with resistors, inductances, and capacitances connected in series. Vector diagrams. Analysis of simple stationary alternating current circuits with resistive, capacitive, and inductive circuit elements using the complex method. **Topic 6:** Triangles of resistances and voltages. Voltage resonance. Currents and voltages in circuits with active resistance, inductive and capacitive elements connected in parallel. Triangles of resistances and currents. Current resonance. **Topic 7:** Inductively coupled circuits.Calculation of inductively coupled circuits. Matching, opposing, series and parallel connection of two coils. Concept of transformers. Ideal and real transformers, their useful working coefficient and vector diagram. **Topic 8:** Three-phase electrical circuits. Concept of three-phase electrical circuits. Connecting consumers in the "star" and "delta" configurations. Symmetrical and nsymmetrical systems.Rotating magnetic field. Concept of asynchronous machines. Measuring power in three-phase circuits. Methods of measuring power in AC circuits **Topic 9:** Non-sinusoidal current circuits.The concept of non-sinusoidal current. Fourier series. Effective and average values and power of non-sinusoidal quantities. Calculation of electrical circuits connected to a non-sinusoidal power source. Topic 10: **Transient processes.Concept of transient processes. Switching laws. Classical calculation of transient processes in simple electrical circuits. Aperiodic, limit aperiodic and oscillatory discharge of a capacitor.** **Topic 11:** Calculation of transient processes using the operator method. Calculation of transient processes using the operator method. Concepts of representation and original. Laplace transform. Operator form of Ohm's and Kirchhoff's laws. Operator scheme. Propagation theorem. Duhamel integral. **Topic 12:** Quadrupoles.Passive quadrupoles and their equations and constants. Equivalent circuits. Connections of quadrupoles. Graphs of

quadrupoles and their matrices. Transfer functions of quadrupoles.

Topic 13: Filters.Basic concepts and classification of frequency-division filters. Low-pass filters. High-pass filters, band-pass filters. Methods of calculating filters. Rules for calculating and plotting the transfer function of a filter.

Topic 14: Electrical circuits with discrete parameters.

Basic concepts of electrical circuits with discrete parameters. Equations of a homogeneous line. Operation of a line in a sinusoidal mode, traveling waves. Interference waves.

Topic 15: Theory of Nonlinear Electrical Circuits.

Elements of nonlinear resistive electrical circuits, their parameters and characteristics. Properties, characteristics and parameters of a ferromagnetic core coil.

Topic 16: Calculation of transient processes in nonlinear electrical circuits. Methods for calculating transient processes and elements of the theory of oscillations in linear and curved circuits.

Topic 17: Electromagnetic field theory.

The integral form of the electromagnetic field equation and the magnitudes of electric and magnetic fields. Some concepts of vector analysis. The differential form of the electromagnetic field equation. Electrostatic field. Electric potential gradient. Poisson and Laplace equations.

Topic 18: Theory of a uniform electromagnetic field.

Dielectric cylinder and condition in a uniform external field. Method of representation. Expression of mechanical force in the form of the volumetric density of the electric field energy and the derivative of the electric field energy with respect to the coordinate in which it changes. Energy of the field of a system of charged bodies.

Topic 19: Calculation of the magnetic field of a constant current. The magnetic field of a constant current. Scalar and vector potential of a magnetic field. Electromagnetic field. Maxwell's equations I and II. Electromagnetic field energy. Umov-Poyting theorem

II. Instructions and recommendations for organizing laboratory exercises.

In laboratory classes, students develop practical skills and competencies in conducting experiments on various connection schemes, calculating and drawing tables and graphs in Theoretical Electrical Engineering. The recommended topics are selected based on opportunities and conditions.

Recommended topics for laboratory work:

1. Series connection of energy consumers in an alternating current circuit. (R, L; R, C; L, C).
2. Parallel connection of energy consumers in an alternating current circuit.
3. Mixed connection of energy consumers in an alternating current circuit.
4. Study of the phenomenon of mutual inductance in alternating current circuits.
5. The phenomenon of resonance in a circuit with elements connected in series.
6. The phenomenon of resonance in an electrical circuit with elements connected in parallel.
7. Study of three-phase electrical circuits connected in a star and star method.
8. Study of three-phase electrical circuits connected in a consumer triangle method.
9. Checking non-sinusoidal quantities in electrical circuits.
10. Checking the transition process of discharging a capacitor into active resistance and inductance.
11. Experimental determination of the parameters of passive

quadrupole.

12. Investigation of high and low frequency filters.

13 Investigation of intermediate and blocking filters (isolators).

14. Investigation of distributed parameter electrical networks.

15. Ferroresonance of voltages.

16. Ferroresonance of currents.

17. Investigation of a ferromagnetic power amplifier.

18. Investigation of a ferromagnetic frequency doubler.

19. Investigation of the refraction of a current occurring at the boundary of media with different relative permittivity.

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:

Topic1.Reconstruction of DC electric circuits. In parallel or series connection, resistors, coils and capacitors are arranged in a sequential manner

Topic 2. Ohm's and Kirchhoff's laws.

Topic 3. Reconstruction of sinusoidal current and linear electric circuits.

Topic 4. Complex method. Analysis of simple stationary electric circuits with resistive, capacitive and inductive circuits using the complex method

Topic 5. Reconstruction of interconnected electric circuits.

Topic 6. Construction of alternating current circuits and vector diagrams with active inductive and capacitive parallel connections.

Topic 7. Resonance of voltages and currents.

Topic 8. Connecting three-phase electrical circuits connected in the form of a "triangle and star".

Topic 9. Non-sinusoidal current and powerful electrical circuits.

Topic 10. Evaluation of transient processes in electrical circuits with lumped parameters by classical and operator methods.

Topic 11. Evaluation of quadrupoles.

Topic 12. Filters. Determination of the support and graph for a simple electrical filter

Topic 13. Reconstruction of electrical circuits with scattered parameters.

Topic 14. Nonlinear electrical circuits with constant current.

Topic 15. Nonlinear magnetic circuits with constant current.

Topic16. Approximation of nonlinear characteristics.

Topic17. Equivalent sinusoidal method.

Topic18. Periodic processes in nonlinear electric and magnetic circuits.

Topic19. Assignment to calculate nonlinear alternating current electric circuits.

Topic20. Calculation of periodic processes by effective values of nonlinear circuits.

Topic21. Calculation of electric circuits with controlled nonlinear elements.

	Topic22. Calculation of transient processes in nonlinear circuits. Topic23. Electrostatic field. Topic24. Image method. Topic25. Calculation of electric capacitance. Topic26. Calculation of the electric field of a constant current. Topic27. Calculating the magnetic field of a constant current **IV. 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 of direct current electrical circuits. 2. Calculation of alternating current electrical circuits by symbolic method. 3. Calculation of three-phase electrical circuits. 4. Calculation of quadrupoles by matrix method. 5. Calculation of transient processes in linear electrical circuits by classical method. 6. Calculation of transient processes in linear electrical circuits by operator method. 7. Propagation theorem. Duhamel integral. 8. Calculation of a three-phase alternating current circuit. 9. Calculation of a direct current magnetic circuit. 10. Calculation of a nonlinear alternating current electrical circuit.
Student assessment	Assessment of student knowledge is based on the mastery of the learning material during the semester and final control (tests, assignments, written and oral work results). During the course of Electrical Networks and Systems, students are evaluated on a 100-point system. Of these, 50 points are allocated to the current and intermediate results (60% of 50 points are current control, independent study and 40% are intermediate control), and 50 points are allocated to the final control results. Students whose total score of current and intermediate points is less than 30 points are not admitted to the final control exam. A student who scores 30 or more points in the final control is considered to have mastered the subject.
Requirements for exams	The student must have fully mastered the theoretical and practical concepts of the subject, be able to correctly reflect the results of the analysis. The student must have completed the tasks given in the current and intermediate forms of independent work, assessment. At the same time, he must have received the necessary points from the current, intermediate, independent education and final tests in the relevant subject within the specified time. A student who has not submitted current control, intermediate control and independent education tasks, as well as who has scored less than 30 points on these tasks and types of control, will not be included in the final type of control. Also, a student who has missed 25 or more percent of the classroom hours allocated to the subject without an excuse will be expelled from this subject, will not be allowed to take the final exam and will be considered as not having mastered the relevant credits in this subject. A student who fails the final exam or scores less than 30 points on this type of exam is considered academically indebted.
Recommended Literature	**Main literature:** **1.** Charles K. Alexander Matthew N.O. Sadiku ―Fundamentals of Electric Circuits‖ NEW YORK, 2014.-458 p 2.John Bird. ―Electrical and Electronic Principles and Technology‖

LONDON AND NEW YORK, 2014.-455 p
3.Karimov A.C. Theoretical electrical engineering. Textbook. -T: Teacher, 2003. - 422 p.
4.Alimkhodjaev K.T, Abdullayev V. A. Abidov K.G. Ibodullaev M.I. Theoretical foundations of electrical engineering. Textbook. ―Science and Technologies‖ Publishing House, Tashkent. 2015, -320 p.
5.Karimov A.S. Ibadullaev M.I. Abdullayev B. Theoretical foundations of electrical engineering. Part 1. Textbook. ―Science and Technologies‖ Publishing House, Tashkent. 2017, -324 p.
6. Alimkhodjayev K.T, Abdullayev B. Abidov K.G. Theoretical electrical engineering. Part 2. Textbook. ―Science and Technologies‖ Publishing House, Tashkent. 2018, -288 p.
7.Amirov S.F, Yakubov M.S, Jabborov N.G. Theoretical foundations of electrical engineering. Parts I- III-Tashkent; 2007.- 426 p.
8.Amirov S.F, Yakubov M.S, Jabborov N.G, Sattorov X.A, Balgaev N.E. Collection of problems on the theoretical foundations of electrical engineering.-T: Sparks of literature, 2015. -420 p.
9. Demirchan K.C, Neyman L.R, Korovkin H.B, hechurin V.L. Theoretical foundations of electrical engineering. - St. Petersburg, 2003.-462 p.
10.Abidov Q.G, Jorayev R, Ernst I.V, Rakhmatullayev A.I.
Methodological instructions for conducting laboratory work on the section "Nonlinear circuits" of the subject "Theoretical foundations of electrical engineering". TDTU, 2014.- 44 p.
11. Abidov Q.G, Begmatov Sh.E. Methodological instructions for conducting virtual laboratory work on the subject "Theoretical foundations of electrical engineering". TDTU, 2013.- 72 p.
12. Abidov Q.G., Rakhmatullayev A.L., Jo’rayev R., Ernst I.V., Kadirova. D.R.Methodological instructions for performing calculation and graphic work on the section “Three-phase circuits” of the discipline “Theoretical foundations of electrical engineering”. TDTU, 2013.-32 p.
13. Abidov Q.G., Kadirova. D.R. Methodological instructions for performing calculation and graphic work on “Transient processes in linear electrical circuits”. TDTU, 2010.- 36 p.

Additional literature:

Mirziyoyev Sh.M. Yangi O'zbekistonda erkin va farovon yashaylik. - T.: "TASVIR nashriyoti", - 2021. - 50 b.
15. Mirziyoyev Sh.M. Milliy taraqqiyot yo‘limizni qat’iyat bilan davom ettiramiz va uni yangi bosqichga ko‘taramiz.-T: “O‘zbekiston”, 2017-592 b.
16. Mirziyoyev Sh.M. Biz buyuk kelajagimizni mard va olijanob xalqimiz bilan birga quramiz. – T: O‘zbekiston Milliy yangi va eng yangi tarix instituti, 2017 – 488 b.
17. O‘zbekiston Respublikasini yanada rivojlantirish bo‘yicha Harakatlar strategiyasi to‘g‘risida. T: 2017 yil 7 fevraldagi PF-4947-son qarori.

Internet resources:

18. www.gov.uz - Government portal of the Republic of Uzbekistan.
www.lex.uz - National database of legislative documents of the Republic of Uzbekistan.
19.www.prezident.uz - Press service of the President of the Republic of Uzbekistan. www.scopus.com - international scientific database.
20. www.ziyonet.uz – national educational materials search site.
21. www.gov.uz – Government portal of the Republic of Uzbekistan.
22. www.google.com – international educational materials search site.
23. www.energystrategy.ru – “Energy Policy and Strategy” information portal
24. www.twirpx.com – international educational materials search site.