Fan name	Theoretical electrical engineering (ECTS 9)
Subject/module code	NAZEL13409
Science taught semester (s).	3rd and 4th semester
Responsible teacher	Akhmedov Abdurauf, Senior teacher
Education language	Uzbek
Study to the program connection	Compulsory
Training hours (this including independent education)	**Total hours - 270.** **Auditory training hours - 108.** Lecture hours - 48 Laboratory study hours - 30 Practical study hours - 30 **Independent education -162 hour**
ECTS	9
The purpose and tasks of subject / learning outcomes	**The purpose of teaching the subject** to solve the problem of preparing future specialists, while developing skills and competencies in 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** is to equip students with theoretical knowledge, practical skills, and the ability to analyze and synthesize the theory of electrical circuits. The task of the discipline "Theoretical Electrical Engineering" is to provide its students with: -elements of electrical circuits and their basic concepts -Basic laws and calculation methods for analyzing constant and alternating current circuits; -resonance phenomena, self-inductance and mutual inductance; -three-phase circuits, periodic non-sinusoidal currents in electrical circuits; -linear electrical circuits transient processes; - basic principles and calculation methods of quadrupoles, electrical filters, and discrete-parameter circuits; -theory of nonlinear electrical circuits; -aimed at analyzing electromagnetic field theory and mastering its synthesis. **Learning outcomes:** 1. DC linear electrical circuits and methods for their calculation are studied. 2. Electric current. Current density. Ohm's law. Electric energy and electric power. Construction of topological equations of complex electric circuits based on Kirchhoff's laws. Equivalent transformation of circuits consisting of series, parallel and mixed connected elements. Equivalent transformations of a triangle of resistances into a star of resistances and vice versa. Proportional contour currents and node potentials and the principle of superposition of the two-node method and its application in the calculation of electric circuits are studied. 3. Single-phase sinusoidal current linear electrical circuits are studied. 4. Can explain the difference between three-phase electrical circuits and. 5. Nonsinusoidal periodic quantities. Nonsinusoidal current circuits. The concept of nonsinusoidal current. Fourier series. 6. Transient processes in electrical circuits. Concept of transient processes. Laws of switching.
Course content (topics)	**I. Main Theoretical Part (Lecture Sessions)** **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. Description, history

	and future development of modern electrical devices. About the science of “theoretical electrical engineering”. The concept of the electromagnetic field and integral quantities used in the theory of electrical circuits. Methods for calculating electrical circuits and their parameters. Basic circuit diagrams of electrical circuits and their concepts, classification laws and electrical methods. The development of electrical engineering and its connection with information computing and automation. Charge. Electric current. Potential and voltage. Power. Energy. **Topic 2:** Complexly connected electrical circuits. Concept of 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. **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. Matrix form. Superposition principle. Equivalent generator method. **Topic 4:** Alternating current electrical circuits. Sinusoidal current electrical circuits. Concept of sinusoidal current generation and electric generators. Concepts of frequency, period, phase, initial phase and amplitude. Effective (effective) and average values of voltage, e.u.k. **Topic 5:** Representation of sinusoidal currents and voltages with vectors and complex numbers. Power. Currents and voltages in circuits with resistors, inductors, and capacitors connected in series. Vector diagrams. **Topic 6:** Resonance in electrical circuits. Triangles of resistances and voltages. Voltage resonance. Currents and voltages in circuits with active conductivity, inductive and capacitive elements connected in parallel. Triangles of conductivity and currents. Current resonance. **Topic 7:** Inductively coupled circuits. Mutually inductively coupled circuits. Calculation of mutually inductively coupled circuits. Matching, opposing series and parallel connection of two coils. Concept of transformers. Their useful work coefficient and vector diagram. **Topic 8:** Three-phase circuits Three-phase electrical circuits. Concept of three-phase electrical circuits. Connecting consumers in "star" and "delta" configurations. Symmetrical and unsymmetrical systems. Rotating magnetic field. Concept of asynchronous machines. Measuring power in three-phase circuits. **Topic 9:** Non-sinusoidal periodic quantities. 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 in electrical circuits.Transient processes.Concept of transient processes.Commutation laws.Classical calculation of transient processes in simple electrical circuits.Aperiodic, limit aperiodic and oscillatory discharge of a capacitor.Operator calculation of transient processes.Image and original concepts.Laplace transform.Operator form of Ohm's and Kirchhoff's laws.Operator circuit.Propagation theorem.Duhamel integral. **Topic 11:** Quadruplets.Passive Quadrupoles and their equations and constants. Equivalent circuits. Connections of quadrupoles. Graphs of quadrupoles and their matrices. Transfer functions of quadrupoles. **Topic 12:** Circuit diagrams, filters. Basic concepts and classification of frequency-division filters. Low-pass filters. High-pass filters, band-pass filters. Methods of calculating filters.

Topic 13: Electrical circuits with scattered parameters.

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

Topic 14: Nonlinear circuits. Theory of nonlinear electrical circuits. Elements of nonlinear resistive electrical circuits, their parameters and characteristics. Properties, characteristics and parameters of a ferromagnetic core coil. Capacitors with nonlinear characteristics. Calculation of DC nonlinear electrical and magnetic circuits. Series and parallel circuits with a ferromagnetic core and mixed-connected sections composed of nonlinear elements with and without a source. Calculation of networked magnetic circuits. Periodic processes in nonlinear electrical and magnetic circuits. Characteristics of periodic processes in electrical circuits with nonlinear elements. Equivalent sinusoidal method. Forms of current, magnetic flux and e.u.k. in a ferromagnetic core coil. Equation, vector diagram and equivalent circuit of a ferromagnetic core transformer. Ferroresonance phenomena occurring in a series and parallel connected ferromagnetic core coil and capacitor circuit. Ferromagnetic voltage stabilizer. Ferromagnetic power amplifier. Ferromagnetic frequency doubler

Topic 15: 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. Characteristics of oscillatory processes in linear and nonlinear circuits. Steady state in a nonlinear active resistance and capacitive circuit. Stability of the regime in a circuit with nonlinear resistance and inductive elements. Stability criterion. Excitation of self-oscillation in a nonlinear system with feedback. Autogenerator. Methods for calculating transient processes in nonlinear electrical circuits. Graphical integration method. Analytical calculation method. Successive interval method. Calculation of transient processes based on the conditional linearization of the circuit equation. Representation of transient processes in the phase plane.

Topic 16: Electromagnetic field theory

Integral form of the electromagnetic field equation and electric and magnetic field constants. Some concepts of vector analysis. Differential form of the electromagnetic field equation. Electrostatic field. Electric potential gradient. Poisson's and Laplace's equations. Electric field through a charged axis and a circular cross-section.

Topic 17: Homogeneous electromagnetic theory.

Dielectric cylinder and sphere in a uniform external field. Method of representation. Expression of mechanical force in the form of the volumetric density of 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 18: Calculation of the magnetic field of a constant current.

Constant current magnetic field. Scalar and vector potential of a magnetic field. Electromagnetic field. Maxwell's equations I and II. Electromagnetic field energy. Umov-Poyting theorem.

II. Guidelines and recommendations for organizing laboratory exercises.

In laboratory classes, students develop practical skills and competencies in calculating and drawing tables and graphs, conducting experiments, and analyzing various indicators of processes in electrical networks and systems. The proposed 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 whose elements are connected in series. 6. Resonance phenomenon in an electrical circuit whose elements are connected in parallel. 7. Study of three-phase electrical circuits connected in a star and star connection. 8. Study of three-phase electrical circuits connected in a consumer triangle. 9. Checking non-sinusoidal quantities in electrical circuits. 10. Investigating the transition process of a capacitor from active resistance to inductance during discharge. 11. Experimental determination of the parameters of passive quadrupole. 12. Study of high and low pass filters. 13. Study of intermediate and descending filters (separators). 14. Study of distributed parameter power networks. 15. Ferroresonance of currents. 16. Voltage ferroresonance. 17. Study of a ferromagnetic power amplifier. 18. Study of a ferromagnetic frequency doubler. 19. Investigating the refraction of a current occurring at the boundary of media with different relative permittivity. **III. Practical for training instructions and recommendations** The teacher's preparation for a practical session begins with studying the initial 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 session, as well as the amount of work that each student must perform. Methodological guidelines are the teacher's main methodological document in preparing and conducting practical classes. The goal of practical training is to understand theory and acquire skills. Its conscious application in educational and professional activities consists in developing the ability to confidently formulate one's own point of view. **Recommended practical topics** : 1. Calculation of alternating current electrical circuits. 2. Ohm's and Kirchhoff's laws. 3. Calculation of sinusoidal current and linear electrical circuits. 4. Comprehensive method. 5. Calculation of inductively coupled electrical circuits. 6. Vector diagrams. 7. Voltage and current resonance. 8. "Calculation of three-phase electrical circuits connected in the form of a "triangle" and a "star". 9. Calculation of non-sinusoidal current and voltage electrical circuits. 10. Calculation of transient processes in electrical circuits with a large number of parameters using classical and operator methods. 11. Calculation of quadrupoles. 12. Filters. 13. Calculation of electrical circuits with discrete parameters. 14. Calculation of DC nonlinear electrical circuits.

	15. Calculation of DC nonlinear magnetic circuits. 16. Calculation of nonlinear DC magnetic circuits. 17. Approximation of nonlinear characteristics. 18. Equivalent sinusoid method. 19. Periodic processes in nonlinear electric and magnetic circuits. 20. Assignment to calculate nonlinear alternating current electrical circuits. 21. Calculation of periodic processes by effective values of nonlinear chains. 22. Calculation of electrical circuits with controlled nonlinear elements. 23. Calculation of transient processes in nonlinear circuits. 24.Electrostatic field. 25. Image method. 26.Calculation of electrical capacity. 27. Calculation of the electric field of a constant current. 28. Calculation of the magnetic field of a constant current. **IV. Independent study 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 DC electrical circuits. 2. Calculation of alternating current electrical circuits using a symbolic method. 3. Calculation of three-phase electrical circuits. 4. Calculation of quadrupoles using the matrix method. 5. Calculation of transient processes in linear electrical circuits using the classical method. 6. Calculation of transient processes in linear electrical circuits using the operator method. 7. Propagation theorem. Duhamel integral. 8. Calculation of a three-phase alternating current circuit. 9. Calculation of a constant current magnetic circuit. 10. Calculation of a nonlinear AC electrical circuit
Student assessment	Assessment of student knowledge is based on the mastery of teaching materials (tests, assignments, written and oral work results) during the semester and final examination. During the Theoretical electrical engineering course, students are assessed on a 100-point scale. Of these, 50 points are allocated to the current and intermediate results (60% of the 50 points are current control, independent study and 40% intermediate control), and 50 points are allocated to the final control result. Students whose total current and intermediate scores are 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. Nazariy elektrotexnika. Darslik. -T.: O'qituvchi, 2003. - 422 b. 4. Alimxodjayev K.T., Abdullayev V. A. Abidov K.G. Ibodullayev M.I. Elektrotexnikaning nazariy asoslari. Darslik. "Fan va texnologiyalar" nashiryoti, Toshkent. 2015, -320 b. 5. Karimov A.S. Ibadullayev M.I. Abdullayev B. Elektrotexnikaning nazariy asoslari. 1-qism. Darslik. "Fan va texnologiyalar" nashiryoti, Toshkent. 2017, -324 b. 6. Alimxodjayev K.T., Abdullayev B. Abidov K.G. Nazariy elektrotexnika. 2-kism. Darslik. "Fan va texnologiyalar" nashiryoti, Toshkent. 2018, -288 b. 7. Amirov S.F., Yoqubov M.S., Jabborov N.G. Elektrotexnikaning nazariy asoslari.I-III qismlar-Toshkent; 2007.- 426 b. 8. Amirov S.F., Yaqubov M.S., Jabborov N.G., Sattorov X.A., Balgayev N.E. Elektrotexnikaning nazariy asoslaridan masalalar toplami.-T.: Adabiyot uchqunlari, 2015. -420 b. 9. Демирчан К.С., Нойман Л.Р., Коровкин Х.Б., Чечурин В.Л. Теоретические основы электротехники. -СПб. Питер, 2003.-462 с. 10. Abidov Q.G'.,Jo'rayev R.,Ernst I.V., Raxmatullayev A.I. «Elektrotexnikaning nazariy asoslari» fanining «Nochiziqli zanjirlar» boMimi bo'yicha laboratoriya ishlarini bajarish yuzasidan uslubiy ko'rsatma. TDTU, 2014.- 44 b. 11. Abidov Q.G'., Begmatov Sh.E. «Elektrotexnikaning nazariy asoslari» fanidan virtual laboratoriya ishlarini bajarish bo'yicha uslubiy ko'rsatmalar. TDTU, 2013.- 72 b. 12. Abidov Q.G'., Raxmatullayev A.L, Jo'rayev R., Ernst I.V., Qadirova. D.R. «Elektrotexnikaning nazariy asoslari» fanining «Uch fazali zanjirlar» bo'limi bo'yicha hisob-grafik ishlarini bajarish yuzasidan uslubiy ko'rsatma. TDTU, 2013.-32 b. 13. Abidov Q.G'., Qadirova. D.R. Chiziqli elektr zanjirlarida o'tkinchi jarayonlar » bo'yicha hisob - grafik ishini bajarish yuzasidan uslubiy ko'rsatma. TDTU, 2010.- 36 b. **Additional literature:** 1. Mirziyoyev Sh.M. Erkin va farovon, demokratik O'zbekiston davlatini birgalikda barpo etamiz. O'zbekiston Respublikasi Prezidentining lavozimiga kirishish tantanali marosimiga bagishlangan Oliy Majlis I palatalarining qo'shma majlisidagi nutqi. —T.: "O'zbekiston" NMIUI 2016.-56 B. 2. Mirziyoyev Sh.M. Qonun ustuvorligi va inson manfaatlarini ta'minlash - yurt taraqqiyoti va xalq farovonligining garovi. O'zbekiston! Respublikasi Konstitutsiyasi qabul qilinganining 24 yilligiga bag'ishlangan tantanali marosimdagi ma'ruza 2016 yil 7 dekabr. - T.: "O'zbekiston" NMIU, 2016. - 48 b.

3. Mirziyoyev Sh.M. Buyuk kelajagimizni mard va Oliy janob xalqimiz bilan birga ko‘ramiz. - T.: “O‘zbekiston” NMIU, 2017. - 488 b.
4. O‘zbekiston Respublikasini yanada rivojlantirish bo‘yicha Harakatlar strategiyasi to‘g‘risida. T.:2017 yil 7 fevral PF-4947-sonli Farmoni.
5. Rashidov Y.R., Abidov Q.G‘., Kolesnikov I.K. «Elektrotexnikaning nazariy asoslari» fanidan 1 -oraliq, 2-oraliq va yakuniy nazorat savollari to‘plami. TDTU, 2002.-102 b.
6. Ibadullayev M. Nazariy elektrotexnika asoslari. Masala va mashqlar to‘plami. I- qism. T.: O‘zbekiston, 2015.- 328 b.
7. Коровкин Х.Б., Селина Е.Е., Чечурин В.Л. Теоретические основы электротехники. Коллекция. -СПб. Питер, 2004. -510 с.
8. Abidov Q.G., Isamuxamedov S.D., Isamuxamedov U.S. «Elektrotexnikaning nazariy asoslari» fanining «O‘zgarmas tok zanjirlari» bo‘limi bo‘yicha hisob- grafik ishlarini bajarish namunalari ko‘rsatilgan. TDTU, 2010.- 40 b.
9. Abidov Q.G., Isamuxamedov S.D., Isamuxamedov U.S. Elektrotexnikaning nazariy asoslari» fanining «O‘zgarmas tok zanjirlari» bo‘limi bo‘yicha hisob- nazariy asoslari fanining o‘zgaruvchan tok zanjirlari bo‘limi bo‘yicha hisob-grafik ishlarini bajarish yuzasidan uslubiy ko‘rsatma. TDTU, 2010.-31 b.
10. Abidov Q.G., Ernst I.V. «Elektrotexnikaning nazariy asoslari» fanining «Nochiziqli magnit zanjirlarini hisoblash» bo‘limi bo‘yicha hisob-grafik ishi bajarish yuzasidan uslubiy ko‘rsatma. TDTU, 2010.- 32 b.
11.Abidov Q.G, Rashidov Y.R. Isamuxamedov S.D. “Elektrotexnikaning nazariy asoslari” fanidan laboratoriya ishlari bajarish uchun uslubiy ko‘rsatma 1-qism.TDTU, 2007.-38 b.
12. Abidov Q.G‘., Rashidov Y.R., Isamuxamedov S.D. “Elektrotexnikaning nazariy asoslari” fanidan laboratoriya ishlari bajarish uchun uslubiy ko‘rsatma 2- qism. TDTU, 2007.- 46 b

Internet resources:

13.www.lex.uz – National database of information on legal documents of the Republic of Uzbekistan.
14.www.ziyonet.uz – national educational materials search site.
15.www.gov.uz – Government portal of the Republic of Uzbekistan.
16.www.google.com – international educational materials search site.
17.www.energystrategy.ru – “Energy Policy and Strategy” information portal
18. www.twirpx.com – international educational materials search site.