Fan name	Theoretical electrical engineering (ECTS 9)
Subject/module code	NAZEL13409
Science taught semester (s).	3rd and 4th semesters
Responsible teacher	Akhmedov Abdurauf Abdug‘ani o‘g‘li, Senior teacher
Education language	Uzbek
Connection to the curriculum	Compulsory
Training hours (this including independent education)	**Total hours - 270.** **3rd semester** **Contact hours - 54.** Lecture hours - 24 Laboratory study hours - 15 Practical study hours - 15 **Independent education -66 hour** **4th semester** **Contact hours - 54.** Lecture hours - 24 Laboratory study hours - 15 Practical study hours - 15 **Independent education -96 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
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	18 points

				of tasks)	
			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. A.S.Karimov, M.Ibadullayev, K.Abidov. Nazariy elektrotexnika. II-III qism. Darslik. – Toshkent.: “Ta’lim nashriyoti” MChJ nashiryoti. 2022, 223-bet.
2. M.Ibadullayev, Q.Abidov, R.Ya.Maxmudov, R.Ch.Karimov. Nazariy elektrotexnika. I-qism. Darslik. – Toshkent.: Zuxro Baraka biznes, 2024, 330-bet.
3. M.Ibadullayev, Q.Abidov, R.Ya.Maxmudov, R.Ch.Karimov. Nazariy elektrotexnika. II-qism. Darslik. – Toshkent.: Zuxro Baraka biznes, 2024, 395-bet.
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-qism. Darslik. “Fan va texnologiyalar” nashiryoti, Toshkent. 2018, -288 b.
7. 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.

Additional literature:

8. 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.
9. Mirziyoyev Sh.M. Qonun ustuvorligi va inson manfaatlarini ta’minlash - yurt taraqqiyoti va xalq farovonligining garovi. O‘zbekiston!
10. Mirziyoyev Sh.M. Buyuk kelajagimizni mard va Oliy janob xalqimiz bilan birga ko‘ramiz. - T.: “O‘zbekiston” NMIU, 2017. - 488 b.
11. O‘zbekiston Respublikasini yanada rivojlantirish bo‘yicha Harakatlar strategiyasi to‘g‘risida. T.:2017 yil 7 fevral PF-4947-sonli Farmoni.
12. Ibadullayev M. Nazariy elektrotexnika asoslari. Masala va mashqlar to‘plami. I- qism. T.: O‘zbekiston, 2015.- 328 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.