Fan name	Electrical Insulation and Cable Engineering (ECTS 5)
Subject/module code	EIKT2405
Science taught semester (s).	4th semester
Responsible teacher	Akhmedov Abdurauf Abdug‘ani o‘g‘li, Senior teacher
Education language	Uzbek
Connection to the curriculum	Elective
Training hours (this including independent education)	**Total hours - 150.** **Auditory training hours - 60.** Lecture training hours - 30 Laboratory training hours - 15 Practical training hours - 15 **Independent education -90 hours**
ECTS	5
The purpose and tasks of subject / learning outcomes	**The purpose of teaching the subject is** to form a level of knowledge in students about electrical insulating materials and their types, their testing, classification of electrical insulating materials, physicochemical, mechanical and electrical properties of electrical insulating materials, the use of electrical insulating materials in the production of cable and conductor products and methods of testing electrical insulating materials, as well as the technology of manufacturing cable products based on educational standards and a set of basic technological operations, as well as the structural structures of cable products. **The task of the subject is** to provide students with in-depth training and analysis of electrical insulating materials used in the electrical engineering and cable industry, to thoroughly teach the main properties of electrical insulating materials, types, and testing methods used in the production of electrical insulating materials. Based on the knowledge gained, to select cables and determine the factors affecting their service life in various operating modes. **Learning outcomes:** 1. To have an idea of the basic terms and concepts of electrical insulation and cable technology, its goals and objectives, the ability to distinguish electrical insulation used in manufacturing enterprises from each other, and the reasons for their origin. 2. The student should know and be able to use electrical insulation and cable techniques and parameters, as well as methods for measuring electrical quantities. 3. The student must have the skills to use and design electrical insulation and cable equipment in manufacturing enterprises.
Course content (topics)	**I. Main Theoretical Part (Lecture Sessions)** **Topic 1:** Introduction. Development stages of power cables and information and communication technologies. **Topic 2:** Basic parts and terminology of cable products. General information about cables. **Topic 3:** Electrical insulation of cables. Dielectric permittivity and capacitor capacity in a constant and alternating electric field. Dielectric permittivity and their types. Equivalent dielectric replacement scheme. Polarization. **Topic 4:** Cable preparation technology. Dipole theory of polarization. Lorentz field and Clausius-Mossoti equation. Elastic and orientational polarization. Static polarization theory. **Topic 5:** City telephone cables . Dielectric as a medium of an electric field. Dielectric capacitance. Accumulation of charge in a dielectric **Topic 6:** Cable insulation wear. Study of polarization of dielectrics depending on the state of aggregation **Topic 7:** Physicochemical and mechanical properties of insulating

	materials. Polarization and dipole moments of molecules. Experimental determination and theoretical assessment of the polarizability of atoms and ions. Dependence of dielectric properties on the structure of matter. Dielectric properties of ionic crystals. Dielectric properties of polymers and glasses. **Topic 8:** Types of cable insulation. Electret effect in dielectrics. Methods of obtaining electrets. Properties of electrets. Piezoelectric and pyroelectric phenomena in dielectrics. Ferroelectrics. Passive dielectrics. **Topic 9:** Coaxial cables with integral polyethylene insulation. The concept of dielectric losses. Types of dielectric losses. Causes of dielectric losses. **Topic 10:** Semi-air polyethylene insulated coaxial cables. The concept of dielectric losses in liquid dielectrics. Causes of dielectric losses in liquid dielectrics. **Topic 11:** Low-frequency symmetrical cables with polyethylene insulation. The concept of dielectric losses in gaseous dielectrics. Causes of dielectric losses in gaseous dielectrics. **Topic 12:** Cable insulation. The concept of dielectric losses in solid dielectrics. Causes of dielectric losses in solid dielectrics. **Topic 13:** Cable current conductor manufacturing technology. General laws of the passage of electric current through a dielectric material. Current balance equation. The emergence of electrical conductivity in various dielectrics **Topic 14:** Semiconductor materials. Reasons for the appearance of charge carriers in gaseous dielectrics. Mobility of charge carriers in gases. Volt-ampere characteristic. Breakdown of gaseous dielectrics **Topic 15:** Magnetic materials. Causes of electrical conductivity in liquid dielectrics and their types. The process of breakdown of liquid dielectrics. The process of breakdown of single and multi-type liquid dielectrics. **Topic 16:** Plastic insulated cable fittings. Fundamentals of the theory of conduction zones of solids. **Topic 17:** Types of cables with plastic insulation. Causes of electrical conductivity in solid dielectrics and their types. The effect of iodine particles on the breakdown process of dielectrics. Theory of electrical conductivity. Electrical conductivity of polarized and non-polarized dielectrics **Topic 18:** Rubber insulated power cables. Nature of ionic conductivity in solid dielectrics, nature of electronic conductivity in solid dielectrics, theoretical description of conductivity and diffusion, Nernst-Weinstein relationship **Topic 19:** Cable types. Explanation of the phenomenon of puncture, types of puncture, breakdown mechanism of dielectric breakdown. **Topic 20:** Hose cables. Types of discharges present in solid, liquid and gaseous dielectric materials and their physical nature **Topic 21:** Mine cables. Piercing of gaseous dielectrics. Use of gaseous dielectrics as insulation **Topic 22:** Special cables and wires. The process of piercing liquid dielectrics. The process of piercing single and multi-layer liquid dielectrics **Topic 23:** Cables with various applications and similar. Study of existing theories of liquid dielectric breakdown process **Subject 24:** Types of insulated wires. Breakdown and breakdown of solid dielectrics. Theoretical laws of breakdown and breakdown mechanism. Theory of breakdown. Theoretical laws of electrical aging. **Topic 25:** Communication cables. Explanation of the phenomenon of puncture, its mechanism and cause of occurrence **Topic 26:** Fiber optic cables. Explanation of the phenomenon of

puncture, its mechanism and cause.

Topic 27: Telephone communication cables. Explanation of the phenomenon of perforation, its mechanism and cause of occurrence

Topic 28: Warranty period and cable service life. Basic rules of theory.

Topic t 29: Cable electrical calculation. Basic rules of the theory

Topic t 30: Cable environmental thermal resistance. Concepts of electrical and thermal aging of dielectrics, the nature of the phenomenon, the causes of aging of dielectrics.

II. Instructions 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.Calculation of surface electrical resistance of electrical insulating materials.

2.Calculation of the volume electrical resistivity of electrical insulating materials.

3.Calculation of the electrical capacitance of electrical insulating materials.

4.Calculation of the electrical strength of solid electrical insulating materials.

5.Calculation of mechanical parameters of electrical insulating materials.

6.Calculation of the dielectric constant of electrical insulating materials.

7. Dielectric conductivity calculation of electrical insulating materials.

8. Cable electricity bill.

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 cable wire strength parameters.

2. Calculation of the conductive core and protective coatings.

3. Calculation of the mass of materials, structural calculation of cable product elements.

4. General information about calculating heating cables, calculating the capacity of drums.

5. Types of tests. Various, acceptance, control, preventive, non-electrical electrical tests of electrical insulating materials.

6. Calculating the accuracy of measurements. Studying the classification and marking of capacitors. Calculating the capacitance, charge, energy, and insulation resistance of capacitors.

7.Electric discharges.

8. Study of various insulators.

	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. Classification of electrical insulating materials (dielectrics) 2. Electrical insulating materials used in the cable industry 3. Electrical insulating materials used in the group of cable and conductor products (high voltage) 4. Electrical insulating materials used in high-voltage insulation 5. Solid dielectrics and their uses 6. Liquid dielectrics and their uses 7. Gaseous dielectrics and their uses 8. Physical properties of electrical insulating materials 9. Chemical properties of electrical insulating materials 10. Mechanical properties of electrical insulating materials 11. Electrical properties of electrical insulating materials 12. Sample testing of electrical insulating materials 13. Control testing of electrical insulating materials 14. Certification testing of cable and wiring products 15. Fire testing of electrical insulating materials 16. Preventive testing of electrical insulating materials 17. Acceptance of electrical insulating materials - assignment test 18. Electrical testing of electrical insulating materials 19. Non-electrical testing of electrical insulating materials 20. Mechanical testing of electrical insulating materials 21. Modern technological refrigeration equipment 22. Modern technological turning equipment 23. Modern technologically efficient equipment 24. Modern technological equipment for applying metal shell 25. Modern technological equipment for wire production 26. Modern technological equipment for the production of high-voltage electric cables with cross-linked polyethylene insulation 27. Modern materials for the production of cable products 28. Modern materials for the manufacture of capacitors 29. Modern materials for the manufacture of insulators
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. A.R. West . R.H. Mitchell . P. Shiv Halasyamani M. Kunz & I.D. Brown . A. Safari, R.K. Panda, V.F. Janas. Dielectric Materials. Chemistry 754, 2002. 2.T.K. Basak. Electrical engineering materials. New Age Intenational, Nil edition. USA, 2009. 3. Ahmedov A.Sh, Kurbanbayeva D.I. Kabel texnikasining nazariy asoslari. O'quv qo'llanma,- Toshkent: TDTU, 2015. 4.Ahmedov A.Sh. Elektr texnika materiallar. O'quv qo'llanma, - Toshkent: TDTU, 2006. 5. Electrical Power Cable Engineering Third Edition By William Thue-watermark. © 2012 by Taylor & Francis Group, LLC CRC Press is an imprint of Taylor & Francis Group, an Informa business **Additional literature:** 4. O'zbekiston Respublikasi Prezidentining 2017 yil 20 apreldagi "Oliy ta'lim tizimini yanada rivojlantirish chora-tadbirlari to'g'risida"gi 2909-sonli Qarori. 5. O'zbekiston Respublikasi Prezidentining 2017 yil 27 iyuldagi "Oliy ma'lumotli mutaxassislar tayyorlash sifatini oshirishda iqtisodiyot sohalari va tarmoqlarining ishtirokini yanada kengaytirish chora-tadbirlari to'g'risida"gi 3151-sonli Qarori. 6. Mirziyoyev SH.M. Buyuk kelajagimizni mard va olijanob xalqimiz bilan birga quramiz. – T.: "O'zbekiston" NMIU, 2017. - 488 b. 7. Mirziyoyev SH.M. Tanqidiy tahlil, qat'iy tartib-intizom va shaxsiy javobgarlik - har bir rahbar faoliyatining kundalik qoidasi bo'lishi kerak. – T.: "O'zbekiston" NMIU, 2017. - 104 b. 8. Mirziyoyev SH.M. Erkin va farovon, demokratik O'zbekiston davlatini birgalikda barpo etamiz. – T.: "O'zbekiston" NMIU, 2017. - 56 b. 9. Mirziyoyev SH.M. Qonun ustuvorligi va inson manfaatlarini ta'minlash - yurt taraqqiyoti va xalq farovonligining garovi. – T.: "O'zbekiston" NMIU, 2017. - 48 b. 10. Пешков И.Б. Кабели и провода. Основы кабелной техники. учебник для студ. высш. учеб. М.: Энергоиздат, 2009; 11. Леонов В. М., И. Б. Пешков, И. Б. Рязанов, С.Д.Холодный Основы кабельной техники: учебник для студ. высш. учеб. М.: Издательский центр «Академия», 2006. **Internet resources:** 12. www.lex.uz – National database of information on legal documents of the Republic of Uzbekistan. 13. www.ziyonet.uz – national educational materials search site. 14. www.gov.uz – Government portal of the Republic of Uzbekistan. 15. www.google.com – international educational materials search site. 16. www.energystrategy.ru – "Energy Policy and Strategy" information portal 17. www.twirpx.com – international educational materials search site.