Fan name	Electrical technical materials (ECTS 5)
Subject/module code	ETM2405
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.** **Contact 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 prepare specialists who can practically apply the elements of electrical engineering, micro- and nanoelectronics. This subject provides initial information about the properties of materials used in various electrical devices, as well as their basic operating principles. **The task of the subject** is to form theoretical and practical knowledge in students on the in-depth study of the base of "Electrical Technical Materials" and the analysis of their main properties from a physical, mechanical, chemical, and technological perspective. **Learning outcomes:** 1. Knowledge of the importance of electrical engineering materials science and to have a skill. 2. Electrical engineering materials, Semiconductor microelectronic devices have the skills to use nanoelectronic materials to be. 3. The development of electrical engineering materials, widely used in the electrical engineering industry must have knowledge and skills about its application.
Course content (topics)	**I. Home Theoretical Part (Lecture Sessions)** **Topic 1:** Introduction. The role of electrical materials in modern electrical engineering. Aggregate states of matter. Defects in crystals. Point and line defects **Topic 2:** Polarization of dielectrics. **Topic 3:** Electrical conductivity of dielectrics **Topic t 4:** Energy losses in dielectrics. Calculation of the dissipation angle δ or tangent of this angle tgδ in dielectrics. Dissipations in gases, liquids and solid dielectrics. Nonpolar dielectric dissipation. Dissipation in polar liquids. Dependence of energy dissipation in liquid dielectrics on viscosity. Dielectric dissipation in a solid with an ionic structure. Dielectric dissipation in ferroelectrics **Topic 5:** Breakdown of dielectrics. Breakdown voltage of dielectrics. Dielectric strength of dielectrics. Electrical strength of air. Electrical strength of liquid dielectrics. Breakdown of solid dielectrics. Electrical breakdown of macroscopically homogeneous dielectrics; electrical breakdown of inhomogeneous dielectrics; thermal breakdown; electrochemical breakdown. **Topic 6:** Electrical engineering materials – Electrical properties of dielectrics **Topic 7:** Thermal characteristics of electrical technical materials **Topic 8:** Physicochemical characteristics of electrical materials Mechanical characteristics of electrical materials. Wetting of dielectrics.

Humidity of materials. Moisture absorption of dielectrics. Mechanical properties of dielectrics. Physical properties of dielectrics. Protection of insulation from moisture. Thermal properties of dielectrics. Effect of high- energy radiation on dielectric properties.

Topic 9: Solid polymer dielectrics.

Solid polycondensation dielectrics

Topic 10: Plastics. Electroceramic materials. Capacitor ceramic materials.

Topic 11: Piezoelectric materials Glass and ceramics Mica and high-frequency dielectrics based on it

Topic 12: Basic properties of metallic conductive materials. Pure metals and alloys used in electrical engineering

Topic 13: Conductor materials with relatively low electrical resistance.

Topic 14: Castings with high electrical resistivity. Winding and electrical installation wires. Cable and wire marking.

Topic 15: Coil and assembly wires and their classification

Topic 16: Classification of semiconductor materials.

Topic 17: Electrical properties of semiconductors. Areas of application.

Topic 18: Magnetic properties of materials.

Types of magnetic materials, Soft magnetic materials

Topic 19: Hard magnetic materials. Ferrites

Topic 20: Electrical insulating varnishes, enamels and compounds

Topic 21: Adhesives, fluxes and adhesive materials

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. Electrical conductivity of insulating materials.
2. In solid dielectrics, dielectric absorption and dielectric identifying energy waste.
3. Determination of the electrical strength of transformer oil.
4. Determination of the electrical resistance of solid dielectrics.

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. Dielectrics under the influence of an electric field.
2. Electrical conductivity in dielectrics.
3. Energy dissipation, breakdown in dielectrics.
4. Electrical resistance of conductive materials.
5. Conductors with high specific resistance
6. Temperature dependence of conductor resistance.
7. Conductivity in semiconductor materials.

	8. Properties of magnetic materials **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. Organic dielectrics. 2. Natural resins. 3. Artificial resins, cellulose. 4. Textile materials. 5. Vegetable oils, Bitumens. 6. Waxy dielectrics. 7. Wood and paper, Lacquered fabrics, Elastomers. 8. Brief information about inorganic dielectrics. 9. Glass, Ceramics, Ceramics. 10. Mica and mica-containing materials. 11. Asbestos, Magnetoelectrics, Piezoelectrics 12. Conductive materials. 13. Semiconductor: Germanium, Silicon. 14. Magnetic materials, Ferrites.
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, 2020.

2.T.K. Basak. Electrical engineering materials. New Age Intenational, Nil edition. USA, 2019.

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, 2016.

5. Electrical Power Cable Engineering Third Edition By William Thue-watermark. © 2018 by Taylor & Francis Group, LLC

CRC Press is an imprint of Taylor & Francis Group, an Informa

	business **Additional literature:** 6. O‘zbekiston Respublikasi Prezidentining 2017 yil 20 apreldagi “Oliy ta’lim tizimini yanada rivojlantirish chora-tadbirlari to‘g‘risida”gi 2909-sonli Qarori. 7. 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. 8. Mirziyoyev SH.M. Buyuk kelajagimizni mard va olijanob xalqimiz bilan birga quramiz. – T.: “O‘zbekiston” NMIU, 2017. - 488 b. 9. 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. **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.