Name of subject	**Mathematical Modeling and Design of Electric Machines (ECTS 10)**
Subject/module code	EMMML16710
Science taught semester (s).	6th and 7th semesters
Responsible teacher	Khudoyberdiev Umid, assistant
Education language	Uzbek
Connection to the curriculum	Compulsory
Training hours (this including independent education)	**Total hours-300** **6th semester** **Contact hours – 60** Lecture training hour – 30 Laboratory training hour – 15 Practical training hour – 15 **Independent education -90 hours** **7th semester** **Contact hours – 60** Lecture training hour – 30 Laboratory training hour – 15 Practical training hour – 15 **Independent education -90 hours**
ECTS	10
The purpose and tasks of subject / learning outcomes	**The purpose of teaching the course** To ensure the level of modern knowledge, skills, and experience required by the educational standard in accordance with the specialization profile of mathematical modeling and design of electric machines. Additionally, to create a foundation for students to acquire the knowledge and skills necessary to study, analyze, and design mathematical models of electric machines. **The objectives of the course** The course aims to teach students how to formulate mathematical equations in the mathematical modeling and design of electric machines, interrelate these equations, and use computer software to model electric machines and transformers in order to determine their electrical and mechanical parameters. Within the scope of the course, students will gain an understanding of electrical, magnetic, electromagnetic, magnetoelectric, and mechanical processes in electric machines and transformers. They will learn to develop and analyze electrical and mechanical equations for circuits of electric machines and transformers, apply these equations in practice, and clearly articulate their reasoning and conclusions. Additionally, the course aims to develop students' practical skills in applying this knowledge in real-world scenarios. **Learning outcomes:** 1.Study the regulatory documents of the higher education system and the organization of the educational process within the credit-module system, with a focus on the integration of mathematical modeling and design of electric machines. 2.Learn higher education technologies and interactive teaching methods applicable to the teaching and learning of electrical machine modeling and design. 3.Study the theoretical concepts related to the mathematical modeling of electric machines, including their electrical, magnetic, and mechanical behaviors. 4.Acquire practical skills to adapt to studying mathematical modeling and design within the credit-module system of higher education.

	5.Master knowledge of global and national development trends and statistics in the field of electric machines and their modeling and design. 6.Analyze the role of mathematical modeling and design of electric machines in industrial and energy production processes. 7.Be able to analyze the classification, structural elements, and parameters of electric machines from a modeling and design perspective. 8.Gain the ability to study and analyze the fundamental processes, equations, and performance characteristics of electric machines using mathematical modeling methods.
Course content (topics)	**I. Main Theoretical Part (Lecture Sessions)** **Topic 1.** Introduction to the Subject of Mathematical and Physical Models of Electric Machines **Topic 2.** Basic Assumptions in the Mathematical Modeling of Electric Machines **Topic 3.** Coordinate Axis Systems Used in the Mathematical Modeling of Electric Machines **Topic 4.** Per Unit System Used in the Mathematical Modeling of Electric Machines **Topic 5.** Methods for Testing Transient Processes in Electric Machines **Topic 6.** Starting DC Motors without a Reostat **Topic 7.** Sudden Short Circuit of a Two-Winding Transformer **Topic 8.** Transient Processes in Asynchronous and Synchronous Machines **Topic 9.** Asynchronous Machine Equations **Topic 10.** Synchronous Machine Equations **Topic 11.** Magnetic Flux Linkages of Synchronous Machine Windings **Topic 12.** Transformation of Voltage Balance Equations from a, b, c Axes to α, β and d, q Axes **Topic 13.** Electromagnetic Torque on the d and q Axes of Synchronous Machines **Topic 14.** Calculation of the Electromagnetic Field in Electric Machines **Topic 15.** Scalar and Vector Potentials of the Magnetic Field **II. Instructions and recommendations for organizing laboratory exercises.** In laboratory exercises, students develop practical skills and competencies in various indicators of processes in electrical machines and systems, conducting experiments, calculating and drawing tables and graphs. The recommended topics are selected based on opportunities and conditions. **Recommended topics for laboratory work:** 1. Preparation of a single-phase two-winding transformer model. 2.Preparation of a three-phase transformer model. 3.Parallel connection of three-phase transformers. 4.Preparation of a short-circuited rotor asynchronous motor model. 5.Preparation of a phase-connected rotor asynchronous motor model. 6.Preparation of a synchronous motor model. 7.Preparation of a synchronous generator model. 8. Preparation of a short-circuited rotor asynchronous motor model. **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**: 1.Study of the basic permissions in the mathematical modeling of electrical machines. 2.Operating modes of a short-circuited rotor asynchronous motor. 3.Designing a complete model of a synchronous machine. 4.Designing a model of a synchronous machine powered by a permanent magnet. 5.Control of constant current motors. 6.Development of techniques for modeling the operating modes of phase transformers and their connections. 7.Development of equations for modeling the operating modes of single-phase and three-phase transformers and their connections **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.Modeling of autotransformers. 2.Modeling of special-purpose transformers. 3.Modeling of welding transformers. 4.Modeling of parallel-connected alternating current machines. 5.Modeling of mixed-connected alternating current machines. 6.Modeling of special-purpose asynchronous machines. 7.Specific aspects of modeling micromachines. 8.Modeling of hysteresis motors. 9.Modeling of reactive motors. 10.Modeling of stepper motors. **V. Topics for course work to be performed within the field of study:** 1.Expressing the operating modes of a short-circuited rotor asynchronous motor through a mathematical model and modeling it in Matlab/Simulink software. 2.Expressing the operating modes of a synchronous motor through mathematical model expressions and modeling it in Matlab/Simulink software. 3.Developing mathematical expressions for the operating modes of a power transformer depending on its load characteristics and modeling the load's dependence on temperature in Ansys software. 4.Developing mathematical expressions for the mechanical and energy characteristics of a short-circuited rotor asynchronous motor depending on the load, and modeling the impact of load on temperature in Ansys software.
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		20 points	Supervision:	10 points	12 points

	assessment		Written work		
			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. Bogusz, P., Korkosz, M., Prokop, J.: Laboratory tests on a two-phase switched reluctance motor designed for high-speed electromechanical drive (in Polish), Maszyny Elektryczne – Zeszyty Problemowe, vol. 105, 2015, No 1, Katowice, Poland, 137–142.

2. G.N. Mustafakulova, O.Z. Toirov, A.E. Bekishev. Elektr mashinalari. Toshkent. Tafakkur avlodi. 2020. 191 b.

3. Berdiev U.T., Pirmatov N.B. Elektromexanika. Texnika oliy o‘quv yurtlarining «Elektr texnikasi, elektr mexanikasi va elektr texnologiyalari» va “Elektr energetika” yo‘nalishi talabalari uchun darslik T.: Shams-Asia. 2018. — 386 b.

4. Pirmatov N.B., Mustafakulova G.N., Maxmadiyev R.M. «Elektr mashinalari» kursidan «Asinxron motorlarni loyihalash». O‘quv qo‘llanma. -T.: ToshDTU, 2016.-95 6.

5. Pirmatov N.B. Elektr mashinalari Darslik -T.: O‘zbekiston faylasuflari milliy jamiyati nashriyoti, 2017.— 408 b.

Additional literature:

6. Mirziyoyev Sh.M. Erkin va farovon, demokratik Uzbekiston davlatini birgalikda barpo etamiz. O‘zR Prezidentining lavozimiga kirishish tantanali marosimiga bag‘ishlangan Oliy Majlis palatalarining qo‘shma majlisidagi nutqi. –T.: "O‘zbekiston" NMIU, 2016.— 56 b.

7. Mirziyoyev Sh.M. Qonun ustuvorligi va inson manfaatlarini taminlash — yurt taraqqiyoti va xalq farovonligining garovi. O‘zR Konstitutsiyasi qabul qilinganining 24 yilligiga bag‘ishlangan tantanali marosimdagi ma’ruza 2016 yil 7 dekabr. — T.: “Uzbekiston” NMIU, 2016.— 48 b.

8. Mirziyoyev Sh.M. Buyuk kelajagimizni mard va oliy janob xalqimiz bilan birga kuramiz. - T.: "O‘zbekiston" NMIU, 2017.— 488 b.

9. N.B. Pirmatov, Z.A. Yarmuxamedova, G.N. Mustafakulova. Elektr mashinalari fanining transformatorlar qismi bo‘yicha kurs loyihasini bajarishga oid o‘quv-metodik qo‘llanma. —T.: ToshDTU, 2018-117 b.

Internet resources:

1. https://www.proquest.com/ International scientific articles and materials website.
2. https://www.academia.edu/ – International educational materials search website.
3. www.ziyonet.uz – National educational materials search website.