Modelling of Mechatronic Systems

SYLLABUS

Code and name of specialty	**141 – Power engineering, electrical engineering and electromechanics**	**Institute / faculty**	**Power engineering, electronics and electromechanics**
Name of the program	**Electric drive, mechatronics and robotics**	**Department**	**Automated electromechanical systems**
Program type	**Educational and professional**	**Language of education**	**English**

Teacher

Full name, ***e-mail*** **Bohdan Vorobiov** ***bohdan.vorobiov@khpi.edu.ua***

Doctor of Philosophy (Ph.D), head of the department of automated electromechanical systems of NTU "KhPI". Work experience - 6 years. Author of more than 30 scientific works. Leading lecturer in the disciplines: "Fundamentals of scientific research", "Modelling of Mechatronic Systems", "Design of power supply systems in mechatronics".

General information about the course

Abstract	The discipline is aimed at providing students with theoretical knowledge about patterns, methods and means of scientific and technical research, solving real problems of identification and modeling of electromechanical objects and systems (EMCs) with the help of personal computers (PCs).
Course objectives	Formation of a future specialist in a clear system of the basics of theoretical knowledge, practical skills and skills of structural and parametric identification of EMC in linear modes of their operation, use of specialized software tools (software) to perform identification based on experimental data and obtain an optimal model of the dynamics of the object or system being studied.
Format	Lectures, practical classes, calculation tasks, consultations. Final control - credit.
Semester	7

Competences: Ability to think abstractly, analyse and synthesise. Ability to solve practical problems using the methods of mathematics, physics and electrical engineering. Ability to solve complex specialised problems and practical problems related to the operation of electrical machines, devices and automated electric drive. Awareness of the need to constantly expand their own knowledge of new technologies in electricity, electrical engineering and electromechanics. Acquiring and using professional knowledge and understanding related to the development and operation of mechatronic devices and systems in compliance with the specified parameters of technological processes. Ability to carry out appropriate calculations to analyse transient and steady-state operation of electric drives and mechatronic modules and systems.

Learning outcomes: Know the principles of operation of electrical machines, devices and automated electric drives and be able to use them to solve practical problems in professional activities. Apply application software, microcontrollers and microprocessor technology to solve practical problems in professional activities. Analyse processes in electric power, electrical and electromechanical equipment, relevant complexes and systems. To select and apply suitable methods for the analysis and synthesis of electromechanical and electric power systems with specified parameters. Solve complex specialised problems in the design and maintenance of electromechanical systems, electrical equipment of power plants, substations, systems and networks. To be able to learn independently, acquire new knowledge and improve skills in working with modern equipment, measuring equipment and application software. Apply appropriate empirical and theoretical methods to reduce electricity losses during its production, transportation, distribution and use. Know and understand the principles of organising the processes of development and operation of mechatronic devices and systems in compliance with the specified parameters of technological processes. Be able to perform calculations to analyse the transient and steady-state operating modes of electric drives and mechatronic modules and systems.

Topics to be covered

Topic 1: Representation of the model in continuous time.
Topic 2. Representation of the model in discrete time.
Topic 3. Discretisation of continuous objects.
Topic 4. Numerical differentiation of signals.
Topic 5. Modelling of discrete-continuous systems.
Topic 6. Basic issues of modelling and synthesis of control systems with random input signals.
Topic 7. Modelling of static nonlinearities.

Topic 8: Methods for calculating dynamic processes in continuous systems.

Form and methods of teaching (a description of teaching methods is provided)
The process of learning in this discipline involves lectures, laboratory work and calculation tasks, independent work and consultations.
During the lectures, the text of lectures with video and audio tabs, with attached catalogues, etc. is used, prepared and distributed to students in advance. This provides an opportunity for a more detailed consideration of some sections of the lecture material and for ongoing control.
Laboratory work is related to the modelling of the main elements and systems of the electric drive using the Matlab package, including those that can be used in the implementation of a bachelor's project.
When working independently, the student must study sections and topics from the recommended literature specified in the curriculum.

Control methods (a description of control methods is provided)
The system of quality control of student learning includes current control and final control in the form of an exam.
Current control is implemented in the form of a survey, defence of laboratory work, individual (calculation) tasks, control works, computer testing.
The control of the component of the work programme, which is mastered during the student's independent work with additional lecture material, is carried out during the defence of the calculation task and the exam.
Semester control is carried out orally on the basis of examination tickets in the amount of educational material determined by the curriculum and within the time limits established by the curriculum.
The student is considered admitted to the semester exam in the discipline provided that he or she has completed all laboratory classes provided for in the curriculum.
Distribution of points received by students
The distribution of points for assessing student performance is calculated individually for each discipline, taking into account the characteristics and structure of the course. The current amount of points that a student can accumulate in a semester can reach both the maximum score and a lower score with the allocation of points for an exam or a test.

Table 1 - Distribution of points for assessing student performance for an exam

Control works	Laboratory works	Calculations	Exam	Sum
20	30	30	20	100

Criteria and system for assessing students' knowledge and skills.

According to the ECTS, the assessment system should be understood as a set of methods (written, oral and practical tests, exams, projects, etc.) used to assess the achievement of the expected learning outcomes by students.

Successful assessment of learning outcomes is a prerequisite for awarding credits to a student. Therefore, statements about the learning outcomes of programme components should always be accompanied by clear and appropriate assessment criteria for awarding credits. This makes it possible to state whether the learner has acquired the necessary knowledge, understanding and competences.

Assessment criteria are descriptions of what the learner is expected to do to demonstrate that the learning outcome has been achieved.

The main conceptual provisions of the system of assessment of students' knowledge and skills are:

1. Improving the quality of training and competitiveness of specialists by stimulating independent and systematic work of students during the academic semester, establishing constant feedback from teachers to each student and timely adjustment of their learning activities.
2. Increasing the objectivity of student knowledge assessment is achieved through control during the semester using a 100-point scale (Table 2). Grades are necessarily converted to the national scale (with the state semester grade of "excellent", "good", "satisfactory" or "unsatisfactory") and to the ECTS scale (A, B, C, D, E, FX, F).

Table 2 - Scale of assessment of knowledge and skills: national and ECTS

Rating score, points	**Score ESTS and its definition**	**National score**	**Evaluation criteria**	
			positive	**negative**
1	**2**	**3**	**4**	**5**

90-100	A	Excellent	- In-depth knowledge of the module's educational material contained in the main and additional literary sources; - ability to analyse the phenomena studied in their interconnection and development; - ability to make theoretical calculations; - answers to questions are clear, concise, logically consistent; - ability to solve complex practical problems.	The answers to the questions may include minor inaccuracies

82-89	B	Good	- A deep level of knowledge in the scope of mandatory material that - provided by the module; - ability to give reasoned answers to questions and make theoretical calculations; - ability to solve complex practical problems.	The answers to the questions contain certain inaccuracies;
75-81	C	Good	- Strong knowledge of the material, - Strong knowledge of the material being studied and its practical application; - Ability to give reasoned answers to questions and make theoretical calculations; - Ability to solve practical problems.	- Inability to use theoretical knowledge to solve complex practical problems.
64-74	D	Satisfactory	- Knowledge of the main fundamental provisions of the material, and their practical application; - Ability to solve simple practical problems.	- Inability to give reasoned answers to questions; - Inability to analyse the material presented and perform calculations; - inability to solve complex practical problems.

60-63	E	Satisfactory	- Knowledge of the main fundamental provisions of the module material, - ability to solve the simplest practical problems.	- Ignorance of certain (non-fundamental) issues from the module material; - inability to express opinions consistently and reasonably; - inability to apply theoretical provisions in solving practical problems
35-59	FX (further study required)	Unsatisfactory	Additional study of the module material can be completed within the timeframe provided by the curriculum.	Ignorance of the basic fundamental provisions of the module's educational material; - Significant errors in answering questions; - Inability to solve simple practical problems.
1-34	F (re-study required)	Unsatisfactory	-	- Complete lack of knowledge of a significant part of the module's educational material; - significant errors in answering questions; -Ignorance of the basic fundamental provisions; -Inability to navigate in solving simple practical problems

Main literature: (list of literature that provides this discipline)

1	Modeling of electromechanical systems: Textbook / Chornyi O.P., Lugovoi A.V., Rodkin D.Y., Sisyuk G.Yu., Sadovoi O.V. – Kremenchuk, 2001. – 410 p.
2	Modeling of electromechanical systems. Mathematical modeling of asynchronous electric drive systems: study guide / O. I. Tolochko.- Kyiv, NTUU "KPI", 2016. - 150 p.

3	Shinkarenko, V.F. Modeling of electromechanical systems [Electronic resource]: a textbook for students of the specialty 141 "Electric power, electrical engineering and electromechanics", specialization "Electric machines and devices" / V.F. Shinkarenko, A.A. Shymanska, V.V Kotlyarova; KPI named after Igor Sikorsky. – Electronic text data (1 file: 10.7 MB). – Kyiv: KPI named after Igor Sikorskyi, 2019. – 253 p.
4	Modeling of electromechanical processes and systems: Teaching. manual / O.V. Danilin, V.M. Chermalykh, P.V. Rosen. - K.: NTUU "KPI", 2007. - 52 p.
5	Lozinsky A.O., Moroz V.I., Paranchuk Y.S. Solving electromechanics problems in MathCAD and MATLAB environments: Tutorial. - Lviv: Publishing House of the State University "Lviv Polytechnic", 2000. - 166 p.
6	Kirylenko O.V., Szegeda M.S., Butkevich O.F., Mazur T.A. Mathematical modeling in electric power engineering: Textbook / – Lviv: 2nd edition. A species of national Lviv Polytechnic University, 2013. - 608 p.
7	Using the MATLAB–Simulink package for modeling dynamic systems and devices: Method. instructions for performing laboratory, calculation and graphic works, course and diploma design for students. special 7.092203 - "Electromechanical automation systems and electric drive" and 7.092204 - "Electromechanical equipment of energy-intensive industries" / Compilers: O.V. Chermalykh, O.V. Danilin, V.V. Kuznetsov. - K.: IVC "Polytechnic", 2004. - 72 p.

Structural and logical scheme of studying the discipline

Table 4: List of disciplines

The study of this discipline is directly based on:	The results of studying this discipline are directly relied upon:
Higher mathematics	Automated electric drive of general industrial installations part 2
Theory of automatic control	Industrial robots
Electric machines	Electrical equipment for cars and electric vehicles
Theory of electric drive	

Lecturer: Ph.D, HoD. Bohdan VOROBIOV. _____

(position, name) (signature)