**CURRENT TRENDS OF ELECTROMECHANICS DEVELOPMENT** GENERAL CHARACTERISTICS OF THE DISCIPLINE CURRENT TRENDS OF ELECTROMECHANICS DEVELOPMENT

The work programme of the discipline is compiled according to the Federal State Higher Professional Education Standards

|  |  |  |  |
| --- | --- | --- | --- |
| Code of the field of study and attainment level | Field of study | Details of the order of the Ministry of Education and Science of the Russian Federation on approval and commissioning of the Federal State Higher Educational Standard | |
| Date | Number of order |
| 13.06.01 | Electrical- and Thermal Engineering | 30 July 2014 | 878 |

*The order of the Russian Ministry of Education and Science dated 30 July 2014 N 878 On Approval of the Federal State Higher Educational Standard in the Area of Focus 13.06.01 Electrical- and Thermal Engineering (level of training of highly qualified personnel)*

*(Registered in the Russian Ministry of Justice on 20 August 2014 N 33707)*

## Abstract of the discipline content

In the course Modern Trends in the Electromechanics Development, the key current problems of modern electric drives and electromechanical systems are studied in detail.

## Planned results of mastering the discipline

As a result of mastering the discipline, a student should obtain the competences as follows:

* the ability to critically analyse and evaluate current scientific achievements, generate new ideas for solving research and practical problems, including in interdisciplinary areas (UC-1);
* the ability to design and implement complex research including inter-disciplinary one based on a holistic and scientific view of the world using knowledge in the field of history and philosophy of science (UC-2).
* the readiness to engage in the work of Russian and international research teams to tackle academic problems (UC-3);
* the readiness to use contemporary methods and technologies of scientific communication in the state and foreign languages (UC-4).
* the ability to follow ethical standards in professional activities (UC-5);
* the ability to plan and accomplish the professional and personal development tasks (UC-6);
* the knowledge of the theoretical and experimental research methodology in the field of professional activities (GPC-1);
* the knowledge of the research culture including using the latest information and communication technologies (GPC-2);
* the ability to develop new research methods and their application in independent research in the field of professional activities (GPC-3);
* the readiness to arrange for the work of a research team in professional activities (GPC-4).
* the readiness for teaching activities in the key higher educational programmes (GPC -5);
* the ability to plan, prepare and perform experimental studies in the specialty (PC-1);
* the ability to process the experiment results (PC-2);
* the ability to develop mathematical models of individual and aggregate elements of the power system (PC-3);
* the ability to develop algorithms and a mathematical apparatus for solving problems in the electric power industry (PC-4).
* the ability to operate modern software systems designed to solve problems in the electric power industry (PC-5);
* the ability to collect, process, analyse and systematise information on the research topic, carry out a choice of methods and means for solving research problems (PC-6);
* the readiness to use the latest achievements of science and advanced technologies in the electric power research (PC-7).

As a result of mastering the discipline, a student should:

**Know:**

* the modern natural-science and applied problems of electrical engineering as well as methods and means to solve them in research, design, production, technological and other types of professional activities,
* the potential areas of development of domestic and foreign technologies used in the electrical equipment.

**Be able:**

* to use innovative technologies at reconstructed and newly constructed electrical facilities.

**Demonstrate skills and experience:**

* in mastering methods for improving the electrical system management systems.

## Discipline scope

|  |  |  |
| --- | --- | --- |
| **Types of the educational work, forms of control** | **Hours, total** | **Study terms,**  **number** |
| **5** |
| In-class learning, hours | **4** | **4** |
| Lectures, hours | 4 | 4 |
| Practical exercises, hours | - | - |
| Laboratory-based work, hours | - | - |
| Self-guided work of students, hours | **104** | **104** |
| Type of interim assessment (credit/test, exam) | **test** | **test** |
| Total work intensity according to the curriculum, hours | 108 | 108 |
| Total work intensity according to the curriculum, credits | 3 | 3 |

# DISCIPLINE CONTENT

|  |  |  |
| --- | --- | --- |
| **Code of section, topic** | **Discipline section, topic\*** | **Content** |
| **Р1** | **Section 1. Electromechanical systems** | Trends in the development of energy-efficient electromechanical systems. Perfection of asynchronous engine designs. New types of the electrical machine insulation. Non-traditional excitation systems for synchronous machines. The principles of combining electrical machines. |
| **Р2** | **Section 2.**  **Energy saving technologies based on adjustable electric drives** | The main ways to reduce power consumption in the steady and transient modes of operation of the electric drive. Energy efficiency of asynchronous electric drives of various production mechanisms. Methods for quantifying the reduction of power consumption in the implementation of regulated electric drives. Features of application and efficiency of use of energy-saving electric drives on objects of housing and communal services. The efficiency of using energy-saving electric drives at industrial facilities |
| **Р3** | **Section 3.** **Up-to-date methods of analysis and synthesis of control systems for the electrical equipment** | Features of the contemporary approach to the automatic control system design: the problem statement, the development of the requirements concerning quality and regulation accuracy, sensitivity to parametric and coordinate perturbations, the development of models, the use of software products to automate the design process. Modern methods for the analysis and synthesis of automatic control systems, problems of digital implementation of regulators and design features with the use of computer technology. |

*\** The discipline may contain division only into sections without specifying topics, or only topics

# STUDY TIME ALLOCATION

## Allocation of the classroom load and independent work by disciplines

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | | | |  |  |  |  |  |  |  | |  | |  |  |  | |  |  | |  | |  | |  | |  | |  | |  | |  | Scope of discipline (credit):3 | | | | | | | | | |
| Discipline section | | | | | | In-class  learning  (hour) | | | | Self-guided work: types, number and volume of activities | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Code of section, topic | | Section, topic | | Total of section, topic (hours) | | Classroom work, total (hour) | Lectures | Practical exercises | Laboratory-based work | Self-guided work of students, total (hour) | | Preparation for in-class learning (hours) | | | | | | | Performing independent extracurricular activities (quantity) | | | | | | | | | | | | | | | | | | | Preparation for the control qualification activities (quantity) | | | | | Preparation for  attestation  by discipline (hour) | | | Preparation for attestation by module in the discipline (hour) | | |
| Total | | Lectures | Pract. seminar classes | Laboratory-based work | Research seminars, conference seminars and colloquiums | | Total | | Homework\* | | Graphical work\* | | Research paper, essay, creative work\* | | Individual or group project\* | | Translation of foreign literature\* | | Calculation work, software development\* | | Calculation and graphical work\* | | Term work\* | Term project\* | | Total | | Test\* | | Colloquium\* | Test if there is an exam | Test if there is no exam | Exam | Integrated assessment of the results of mastering the module disciplines | Integrated module exam | Preparation and defence of the module project |
| Р1 | | Electromechanical systems | | 30 | | 2 | 2 |  |  | 28 | | 4 | | 4 |  |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  |
| Р2 | | Energy-saving technologies based on the regulated electric drives | | 34 | | 2 | 2 |  |  | 32 | | 4 | | 4 |  |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  |
| Р3 | | Up-to-date methods of analysis and synthesis of control systems for the electrical equipment | | 40 | |  |  |  |  | 40 | |  | |  |  |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  |
|  | |  | |  | |  |  |  |  |  | |  | |  |  |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  |
|  | |  | |  | |  |  |  |  |  | |  | |  |  |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  |
|  | | Total (hour), without taking into account the preparation for the attestation activities**:** | | 104 | | 4 | 4 | 0 | 0 | 100 | | 8 | | 8 |  | 0 | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | 0 | | 0 | | 0 | | 0 |
|  | | Discipline, total (hour): | | 108 | | 4 |  | | | 100 | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | **0** | 4 | 0 | **0** | **0** | **0** |
|  | | | \* The total amount in hours per activity  is specified in line ‘Total (hour) without taking into account the preparation for the attestation activities’ | | | | | | | | | | | | | | |  |  |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  |  |  | |

# ORGANISATION OF PRACTICAL CLASSES AND SELF-GUIDED WORK OF STUDENTS ON THE DISCIPLINE

## Laboratory work

Not applicable

## Practical exercises

Not applicable

* 1. **Sample topics of the self-guided work**

### An indicative list of homework topics

Not applicable

### An indicative list of the graphical work topics

Not applicable

### An indicative list of the research paper topics (essays, creative works)

Not applicable

### An indicative list of the calculation work topics (software solutions)

Not applicable

### An indicative list of the calculation and graphical work topics

Not applicable

### An indicative list of the term project topics (term works) [*list*]

Not applicable

### Sample topics of the colloquiums

Not applicable

# RELATION BETWEEN THE DISCIPLINE SECTIONS AND APPLIED TEACHING TECHNOLOGIES\*

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Code of section, discipline topics** | **Active learning methods** | | | | | | **Distant learning technologies and e-learning** | | | | | |
| Project work | Case studying | Business games | Problem training | Teamwork | Other (please specify) | Network training courses | Online workshops and simulators | Webinars and videoconferences | Asynchronous web-conferences and seminars | Collaboration and content development | Other (please specify) |
| Р1 |  |  |  | \* |  |  |  |  |  |  |  |  |
| Р2 |  |  |  | \* |  |  |  |  |  |  |  |  |
| Р3 |  |  |  | \* |  |  |  |  |  |  |  |  |

\*mark with an asterisk or another symbol the applied teaching technologies by the discipline section and topic.

# 6. PROCEDURES FOR MONITORING AND EVALUATION OF THE LEARNING OUTCOMES

Not applicable

**7. PROCEDURES FOR EVALUATING THE LEARNING OUTCOMES WITHIN THE INDEPENDENT TEST CONTROL**

Not applicable

# 8. SET OF EVALUATION TOOLS FOR THE CURRENT AND INTERIM ATTESTATION BY THE DISCIPLINE (Annex 1)

# 9. ACADEMIC AND INFORMATION SUPPORT TO THE DISCIPLINE

## 9.1. Recommended literature

## 9.1.2. Additional references

1. [Landau I.D., Zito G. Digital Control Systems: Design, Identification and Implementation*.*](http://www.twirpx.com/file/49586/) Series Communications and Control Engineering. London: Springer, 2006. 484 pp.
2. Astrom K.J., Wittenmark B. Adaptive control. Second edition. Dover Publications, Inc., Mineola, New York, 2008. 573 p.
3. Astrom K.J., Wittenmark B. Computer Controlled System. Theory and Design. Third Edition. Prentice Hall, 2002. 557 pр.

1. [Austin Hughes](http://www.twirpx.com/file/193280/)*[.](http://www.twirpx.com/file/193280/)* [Electric Motors and Drives](http://www.twirpx.com/file/193280/)*[.](http://www.twirpx.com/file/193280/)* Third edition. Elsevier, 2006. 410 рp.
2. Doyle J.C., Francis B.A., Tannenbaum A.R. Feedback control theory. Englewood Cliffs, NJ: MacMillan, 1992. 202 рp.
3. Fadali M. Sam. Digital Control Engineering. Analysis and Design. Burlington: Elsevier Inc., 2009. 523 pp.
4. Normey-Rico J.E., Camacho E.F. Control of Dead-time Processes. London: Springer-Verlag Limited, 2007. 462 pp.
5. [Ogata K. Discrete-Time Control Systems.](http://www.twirpx.com/file/44657/) Second Edition. New Jersey: Prentice Hall, Inc., 1995. 744 pp.
6. [Zhong Q.-C. Robust Control of Time-delay Systems.](http://www.twirpx.com/file/48642/) London: Springer, 2006. 242 pp.
7. 11. [Zhou K., Doyle J.C., Glover K. Robust and Optimal Control.](http://www.twirpx.com/file/46634/) Engelwood Cliffs, NJ: Prentice Hall, 1996. 586 pp.

## 9.2. Guidance papers

Not applicable

## 9.3. Software

MATLAB package

## 9.4. Databases, information, reference and search systems

## <http://lib.urfu.ru> UrFU library site

<http://study.urfu.ru> UrFU information and educational resources portal

## 9.5. Electronic educational resources

Not applicable

**ANNEX 1**

**to the work programme of the discipline**

**8**. **SET OF EVALUATION TOOLS FOR THE CURRENT AND INTERIM ATTESTATION BY DISCIPLINE**

**8.1. CRITERIA FOR THE EVALUATION OF RESULTS OF THE TEST AND EVALUATION ACTIVITIES OF THE CURRENT AND INTERMEDIATE ATTESTATION BY DISCIPLINE**

The criteria approved at the Chair for assessing the students’ achievements per each monitoring and evaluation activity. The set of evaluation criteria as well as during the intermediate certification on a module is based on three levels of mastering the competence components, i.e. threshold, higher and high.

|  |  |  |  |
| --- | --- | --- | --- |
| Competence components | Features of the level of mastering competence components | | |
| threshold level | higher level | high level |
| Knowledge | A post-graduate student demonstrates the acquaintance knowledge, copy knowledge, i.e. recognises objects, phenomena and concepts, finds some differences in them, shows the knowledge of the sources of information, can independently carry out reproductive actions on knowledge by self-reproduction and application of the information. | A post-graduate student demonstrates the analytical knowledge, i.e. confidently reproduces and understands the acquired knowledge, assigns them to one or another classification group, independently arranges them, establishes interrelations between them and effectively applies them in familiar situations. | A post-graduate student can independently obtain new knowledge from the surrounding world and creatively use it to make decisions in new and unusual situations. |
| Skills | A post-graduate student is capable of correctly performing the prescribed actions following the instructions and/or an algorithm in a known situation, independently performing actions to address typical issues that require a choice from among the known methods, in predictably changing situations | A post-graduate student is capable of independently performing the actions (techniques, operations) to solve non-standard problems that require selection based on a combination of known methods, in an unpredictably changing situation | A post-graduate student is capable of independently performing the actions associated with solving research problems, demonstrates the creative use of skills (technologies) |
| Personal qualities | A post-graduate student has a low learning motivation, shows an indifferent, irresponsible attitude to studying and/or the assigned task. | A post-graduate student has a pronounced learning motivation and demonstrates a positive attitude towards learning and future activities, and is active. | A post-graduate student has a developed motivation for training and work, shows perseverance and enthusiasm, hard work, independence and creativity. |

**8.2. APPRAISAL TOOLS FOR CONDUCTING THE CURRENT AND INTERMEDIATE ATTESTATION**

**8.3.1.** **Sample tasks for conducting mini-control in the training sessions**

Not applicable

**8.3.2**. **Sample test problems as part of the classroom sessions**

Not applicable

**8.3.3.** **Sample test cases**

Not applicable

**8.3.4.** **A list of sample test topics**

Not applicable

**8.3.5.** **A list of sample questions for a test**

1. Trends in the development of energy-efficient electromechanical systems.
2. Areas of improving the design of electrical machines.
3. New types of electric insulation of the electrical machines.
4. Principles of combining electrical machines.
5. Key ways to reduce power consumption in the steady-state and transient modes of operation of an electric drive.
6. Energy efficiency of the asynchronous electric drives for various production mechanisms.
7. Methods for quantifying the reduction of power consumption in the implementation of regulated electric drives.
8. Peculiarities of application and efficiency of use of energy-saving electrical drives at the housing and utilities infrastructure.
9. Efficiency of using energy-saving electric drives at industrial facilities.
10. Features of the modern approach to the design of automatic control systems for electric drives.
11. Contemporary methods of the analysis and synthesis of automatic control systems for electric drives.
12. Contemporary methods of research of quality of regulation.
13. Methods for research into the electric drive’s sensitivity to parametric disturbances.
14. Methods for research into the electric drive’s sensitivity to external disturbances.

Contemporary methods of synthesis of electric drive regulators.

**8.3.6. A** **list of sample questions for the exam**

Not applicable

**8.3.7.** **UrFU** **attestation and pedagogical measuring materials, UrFU** **means of control of the educational achievements for conducting the test control within the current and intermediate attestation**

Not applicable

**8.3.8**. **Federal exam in vocational education resources** **for independent testing**

Not applicable

**8.3.9.** **Internet simulators**

Not applicable