**INTELLIGENT ELECTROMECHANICAL SYSTEM MANAGEMENT SYSTEMS** GENERAL DESCRIPTION OF THE DISCIPLINE *INTELLIGENT ELECTROMECHANICAL SYSTEM MANAGEMENT SYSTEMS*

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 | Date |
| 13.06.01 | Power Engineering and Electrical Engineering | 30 July 2014 | 30 July 2014 |

*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

The discipline *Intelligent Electromechanical System Management Systems* studies the fundamentals of the theory and methodology of creating intelligent control systems and the construction on their basis of mechatronic systems for process control and robotic systems.

## Discipline mastering outcome planned

As a result of mastering the discipline, students should obtain the competencies as follows:

* the research culture, also by making use of the latest information and communication technologies (GPC-2);
* the ability to develop new research methods and use them in independent research activities in the professional activities (GPC-3);

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

**Know:**

* modern natural science and applied problems in the field of intelligent control systems in electrical engineering, methods and means for their solution in research, design, production, technology-related and other professional activities,
* perspective areas of development of both domestic and foreign intellectual control technologies used in the electrical machinery.

**Be able:**

* to apply innovative technologies on reconstructed and newly constructed electrical facilities.

**Demonstrate skills and experience:**

* methods for improving the electrical system management systems.

|  |  |  |
| --- | --- | --- |
| **Types of educational activity, forms of control** | **Total, hours** | **Term,**  **number** |
|  |  | 6 |
| **In-class learning, hours** | 4 | 4 |
| Lectures, hours | 4 | 4 |
| Practical exercises | - | - |
| Laboratory research | - | - |
| **Self-guided** **of graduate students including all the types of the current attestation** | 104 | 104 |
| **Interim attestation** | test | test |
| **Total work input by curriculum, hours** | 108 | 108 |
| **Total work input by curriculum, credits** | 3 | 3 |

1. **DISCIPLINE CONTENT**

|  |  |  |
| --- | --- | --- |
| **Section and subject code** | **Section, subject of**  **the discipline\*** | **Content** |
| Р1 | Section 1. Intelligent systems | The artificial intelligence research subject. Historical overview. Knowledge representation systems, i.e. frames; predicate calculus; system of products, semantic networks and fuzzy logic. Methods for finding solutions: Methods for finding solutions in the state space; methods for finding solutions based on the predicate calculus; task sequence planning; search for solutions in productions systems. |
| Р2 | Section 2. Methodology for building expert systems | Expert systems: Definitions and classification; difficulties in the development of expert systems; methodology for building expert systems. |
| РЗ | Section 3. Artificial intelligence-powered robotic systems | Robotic engineering development, i.e. creating intelligent robots, the example of a robotic machine; the structure and composition of the intellectual robotic system; a new generation of process machinery; the unity of mechanical engineering and management in the modern process machinery; operating mechanisms; engineering process; control system.  Intelligent control system of the robotic machine: the process machine control system; the control system composition and the functional characteristics of its elements; additional sensors in solving the direct and inverse kinematics problem; a built-in optical system for surface monitoring.  The systems for the geometric parameter control and quality recognition of the machined surfaces: Optical control systems; physical and mathematical foundations of optical control systems; surface quality control (its roughness); control of products of the complex shape.  Additional embedded control elements in the parallel structure mechanisms: additional control elements; errors in the output link; interrelation of sensor errors and the terminal link of the mechanism. |

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

# STUDY TIME ALLOCATION

**3.1. Distribution of the classroom load and self-guided activities in the disciplines**

Scope of discipline (credits) 3

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Discipline section | | | In-class load  (hours) | | | | Self-guided work - type, quantity and scope of activities | | | | | | | | | | | | | | | | | | | | | | | | |
| Code of section, topic | Name of section, topic | Total of section, topic (hours) | Total | Lectures | Practical exercises | Laboratory-based work | Self-guided work, total | Preparation for in-class learning (hours) | | | | | Total (hours) | Performing independent extracurricular activities (scope) | | | | | | | | | **Preparation for test activities (quant.)** | | | **Preparation for the discipline attestation activities (hour)** | | | **Preparation for attestation activities by the module in the discipline (hours)** | | |
| Total | Lectures | Practical seminar classes | Laboratory-based work | Research seminars, conference seminars and colloquiums | Homework\* | Graphical work\* | Research paper, essay, creative work\* | Individual or group project\* | Translation of foreign literature\* j | Calculation wok, programme development\* | Calculation and graphical work\* | Term paper/ multi-disciplinary term work\* | Term paper/ multi-disciplinary term project\* | Total | Test work\* | Colloquium \* | Test given there is an exam | Test if there is no exam | Exam | Integrated assessment of the results of mastering the module disciplines | Integrated module exam | Execution and defence of the project by module |
| P1 | Intelligent systems | 30 | 2 | 2 |  |  | 28 | 4 | | 4 |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |
| P2 | Methodology for building expert systems | 34 | 2 | 2 |  |  | 32 | 4 | | 4 |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |
| P3 | Artificial intelligence-powered robotic systems | 40 |  |  |  |  | 40 |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |
|  | Total excluding the preparation for attestation: | 104 | 4 | 4 | 0 | 0 | 100 | 8 | | 8 |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 |
|  | Discipline, total (hours) | 108 | 4 |  |  |  | 100 |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  | 0 | 4 | 0 | 0 | 0 | 0 |

\*The total amount in hours for an activity is indicated in the line ‘Total (hour), excluding preparation for the attestation activities’

# ORGANISATION OF PRACTICAL LESSONS, SELF-WORKING AND ATTESTATION BY DISCIPLINE

## 4.1 Laboratory practicum

Not applicable.

## 4.2 Practical exercises

Not applicable

## 4.3 Sample topics of the self-guided work

### 4.3.1. An indicative list of homework topics

Not applicable

### 4.3.2. An indicative list of graphical work topics

Not applicable

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

Not applicable

### 4.3.4. An indicative list of calculation work topics (software products)

Not applicable

### **4.3.5. An indicative list of calculation and graphical work topics**

Not applicable

### **4.3.6. Sample topics of the term project (work)** [list]

Not applicable

### **4.3.7. Sample topics of the colloquiums**

Not applicable

# RELATION BETWEEN THE DISCIPLINE SECTIONS AND THE APPLIED EDUCATION METHODS AND TECHNOLOGIES

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Code of section, discipline topic** | **Active teaching methods** | | | | | | **Distance learning technologies and e-learning** | | | | | |
| Project work | Case studying | Simulation exercises/ management games | Problem-based learning | Teamwork | IT | Network training courses | Virtual workshops and simulators | Webinars and videoconferences | Asynchronous web-conferences and seminars | Collaboration and content development | Other (please specify) |
| P1 |  |  |  | \* |  | + |  |  |  |  |  |  |
| P2 |  |  |  | \* |  | + |  |  |  |  |  |  |
| P3 |  |  |  | \* |  | + |  |  |  |  |  |  |

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

# PROCEDURES FOR THE TRAINING RESULTS MONITORING AND EVALUATION

Not applicable

# PROCEDURES FOR EVALUATING THE TRAINING RESULTS WITHIN THE INDEPENDENT TEST CONTROL

Not applicable

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

# LEARNING, TEACHING AND INFORMATION SUPPORT

**References**

1. CLIPS Reference Manual, Volume I, Basic Programming Guide, 2003.
2. Winston Р.Н. Artificial Intelligence (3rd Edition). Addison-Wesley Pub Co; 3rd edition, 1992. 691 p.

**Databases, information, reference and search systems**

* + - 1. UrFU Library site: http://lib.urfu.ru
      2. UrFU Information Educational Resource Portal: http://study.urfu.ru
      3. Russian Artificial Intelligence Association, http://www.raai.org
      4. Russian Robotics Site: http://www.microbot.ru
      5. RoboClub - Practical Robotics: http://www.roboclub.ru
      6. Content of the Discipline Artificial Intelligence Engines of the Computer Engineering Department of the Novosibirsk State Technical University:

http://vt.cs.nstu.ru/site/subjects/s\_sii.phtm

Fuzzy logic, fuzzy systems and soft computing: http://fuzzy.kstu.ru/pub\_rus.htm

**ANNEX 1**

**to the work programme of the discipline**

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

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



Approved at the Chair criteria for assessing the achievements of students for each monitoring and evaluation event. The evaluation criteria as well as the intermediate appraisal by module are based on three levels of mastering the competence components, i.e. threshold, higher and high levels.

|  |  |  |  |
| --- | --- | --- | --- |
| 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.** **Exemplary tasks for conducting mini-control in the framework of training sessions**

Not applicable

**8.3.2**. **Exemplary test tasks in the framework of training sessions**

Not applicable

**8.3.3.** **Exemplary test cases**

Not applicable

**8.3.4.** **List of exemplary tests**

Not applicable

**8.3.5. List of sample questions for passing a test**

1. The main properties of intelligent robotic systems (IRS).
2. Methods and constructive solutions for the IRS creation.
3. Examples of specific implementations of IRS for solving process-related problems.
4. Prospects for the creation of intelligent systems for contemporary engineering processes.
5. Problems of developing methods and software for solving complex intellectual problems, such as entering knowledge about objects in a complex spatial environment, working with three-dimensional fast-moving objects and managing high-tech equipment in real time.
6. Mechatronic elements embedded in intelligent systems.

**8.3.6. List of sample questions for the exam**

No applicable

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

No applicable

**8.3.8**. **Federal online exam in the field of vocational education for independent testing**

No applicable

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

No applicable