**AL-FARABI KAZAKH NATIONAL UNIVERSITY**

**Faculty of Chemistry and Chemical Technology**

**Department of Chemical Physics and Material Sciences**

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|  | **Approved**  on the meeting of Scientific Council of the Faculty of Chemistry and Chemical Technology Protocol № \_\_\_ of "\_\_\_\_" \_\_\_\_\_\_\_ 2015Dean of Faculty \_\_\_\_\_\_\_\_\_\_ Ongarbayev E.K. |

**SYLLABUS**

«Methods of Investigation and Diagnosis of Nanoobjects and Nanosystems»

1 course, english branch, fall semester, number of credits 3

**Lecturer:**

Umbetkalyev K.A., PhD, associated professor,

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**Tutor (practical, seminars, laboratory work):**

Umbetkalyev K.A., PhD, associated professor,

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**PASSPORT of module:**

Target (single module, is formulated in accordance with the module name and a given synthesized goals disciplines included in the module).

“Current State and Perspective of Development of Nanochemistry” activates knowledge doctoral students in physics, mathematics, the structure of matter. The course is a theoretical and practical introduction to the modern physical doctoral research methods, their capabilities and limitations in dealing with specific experimental tasks; develop the ability to use a set of physical techniques to solve specific problems as when the final works, and in the subsequent practical and research activities.

**Objectives:** (a single list, the task of unifying the disciplines within the module, the problem must necessarily be directed to the formation of the competences set out in the Specifications).

As a result of studying the course doctoral students must:

have an idea about the basics of research methods and diagnostics of nano-objects and nanosystems. Scanning electron microscopy and transmission. Electronic imaging. Electron spectroscopy. Diffraction methods. Optical and nonlinear optical diagnostic methods. Features confocal microscopy. Scanning probe microscopy: force microscopy. Spectroscopy of atomic force interactions. Tunneling microscopy and spectroscopy. Optical microscopy and near-field polarimetry. Application of scanning probe microscopy in nanotechnology.

**Learning outcomes** for the module (combined results of disciplines in the system of competences, see. Specification).

- General competence:

instrumental: to have a clear idea of the general principles of the microscope

interpersonal: During the course of the study will be conducted several workshops in which students will have the opportunity to report on the use of scanning probe microscopy for the study of promising new nanomaterials based on articles leading scientific publications and online publications.

System: In the course of the course students will have real practical skills training on scanning probe microscopes and conduct measurements of various materials with nanometer spatial resolution.

- Subject expertise: Special attention will be devoted to the theoretical and practical development of methods of mathematical processing and quantitative image analysis of scanning probe microscopy.

**Prerequisites, posrequisites.**

For the successful assimilation of the material of the discipline "Methods diagnosis nanostructures and nanosystems" need to know the general course of physics in the series of general mathematical and scientific disciplines. In turn, knowledge of the special course "Methods of nano-objects and nano-diagnostics" can be recommended for further successful study course "Introduction to Nanotechnology" and "Physical Chemistry of Nanostructured Materials." Study of the subject is also recommended for students who plan to use the techniques of scanning probe microscopy in carrying out projects and dissertations.

**STRUCTURE AND SCOPE OF DISCIPLINE**

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| --- | --- | --- | --- |
| Week | Discipline - «Current State and Perspective of Development of Nanochemistry» | | |
| Title | **Hour** | **SWS** |
| Module - Methods of diagnostics of nanoobjects and nanosystems | | | |
| 1 | Lecture 1. Methods of research and diagnostics of nano-objects and nanosystems.  Practical (laboratory) lesson 1 «Study of ceramic materials» | 1  1 | Methods of research of nanoobjects and nanosystems. |
| 2 | Lecture 2. Scanning electron microscopy and transmission.  Practical (laboratory) Session 2 "Сarbonaceous material" | **1**  **1** |
| 3 | Lecture 3 electron tomography.  Practical (laboratory) Session 3 "research tissue" | **1**  **1** | Examples of use for electron tomography |
| **Module 2 - Electron spectroscopy.** | | | |
| 4 | Lecture 4 Electron spectroscopy.  Practical (laboratory) lesson 4 "materials" | **1**  **1** |  |
| 5 | Lecture 5 diffraction methods.  Practical (laboratory) lesson 5 "Quartz-bearing materials" | **1**  **1** | Solving problems by diffraction methods |
| 6 | Lecture 6 Optical and nonlinear optical diagnostic methods. Practical (lab) session 6 "glass-material" | **1**  **1** |  |
| 7 | Lecture 7 Features confocal microscopy.  Practical (laboratory) lesson 7 siliceous materials " | **1**  **1** | The use of nonlinear-optical methods of diagnostics |
| 8 | РК 1 |  |  |
| **Module 3 - Scanning Probe Microscopy** | | | |
| 9 | Lecture 8 Scanning Probe Microscopy:  Practical (laboratory) lesson 8 "biological material" | **1**  **1** |  |
| 10 | Lecture 9 force microscopy.  Practical (laboratory) Activity 3 ", the graphite material" | **1**  **1** | Solving problems by force microscopy |
| 11 | Lecture 10 Spectroscopy of atomic force interactions.  Practical (laboratory) lesson 10 "liquid fuel" | **1**  **1** |  |
| **Module 4 - Tunneling microscopy and spectroscopy** | | | |
| 12 | Lecture 11 Tunneling Microscopy and Spectroscopy.  Practical (laboratory) lesson 11 "Graphene’s" | **1**  **1** | Solving problems by tunneling microscopy |
| 13 | Lecture 12 Optical microscopy and near-field polarimetry.  Practical (laboratory) lesson 12 "nanocatalysts" | **1**  **1** |  |
| 14 | Lecture 13 Application of scanning probe microscopy in nanotechnology.  Practical (laboratory) Session 3 "nanostructured catalysts" | **1**  **1** | Using a probe microscope for surface analysis of catalysts |
| **15** | **РК2** |  |  |

**Key concepts in the discipline of knowledge and competence:** scanning, probe, power, tunneling microscopy

**References**

**Summary**

1. Борисенко, В. Е. Наноэлектроника: учебное пособие / В. Е. Борисенко, А. И. Воробьева, Е. А. Уткина. - М.: БИНОМ. Лаборатория знаний, 2009. - 223 с.: ил

2. Введение в процессы интегральных микро- и нанотехнологий. В 2-х т. - М.: БИНОМ. Лаборатория знаний, 2010. - (Нанотехнологии). Т. 1: Физико-химические основы технологии микроэлектроники / Ю. Д. Чистяков, Ю. П. Райнова. - 2010. - 392 с.: ил. Т. 2: Технологические аспекты. - 2011. - 252 с.: ил.

3. Нанотехнологии. Азбука для всех / ред. Ю. Д. Третьяков. - 2-е изд., испр. и доп. - М.: Физматлит, 2010. - 366 с.: ил.

5. Получение и исследование наноструктур: лабораторный практикум по нанотехнологиям / ред. А. С. Сигов. - М.: БИНОМ. Лаборатория знаний, 2010. - 146 с.: ил. - (Нанотехнологии).

6. Рощин, В. М. Технология материалов микро-, опто- и наноэлектроники: учебное пособие / В. М. Рощин, М. В. Силибин. - М.: Бином. Лаборатория знаний, 2010. Ч. 2. - 2010. - 180 с.

7. Справочник Шпрингера по нанотехнологиям. В 3-х т. - М.: ТЕХНОСФЕРА, 2010. - (Мир материалов и технологий). Т. 1 / ред. Б. Бхушан, пер. с англ., ред. А. Н. Сауров. - 2010. - 862 с.: ил. Т. 2 / ред. Б. Бхушан, пер. с англ., ред. А. Н. Сауров. - 2010. - 1040 с.: ил. Т. 3 / ред. Б. Бхушан, пер. с англ., ред. А. Н. Сауров. - 2010. - 832 с.: ил.

**Additional**

1. Дьячков, П. Н. Электронные свойства и применение нанотрубок / М.: БИНОМ. Лаборатория знаний, 2011. - 488 с.: ил.
2. Нанонаука и нанотехнологии: энциклопедия систем жизнеобеспечения / ред.: О. О. Аваделькарим, Ч. Бай, С. П. Капица. - М.: Изд. Дом "Магистр-Пресс, 2009. - 992 с.: ил.
3. Уорден, К. Новые интеллектуальные материалы и конструкции. Свойства и применение / К. Уорден; пер., ред. С. Л. Баженов. - М.: Техносфера, 2006. - 224 с.
4. Хартманн, У. Очарование нанотехнологии / У. Хартманн; пер. с нем. Т. Н. Захарова; ред. Л. Н. Патрикеев. - 2-е изд., испр.. - М.: БИНОМ. Лаборатория знаний, 2010. - 174 с.: ил.

**Tasks and guidelines for SWS/SWSL**.

Forms of knowledge and competencies:

Examinations: 2 works in the semester.

SWS: individual and group assignments, depending on the technology of the organization of the SWS (abstract, presentation, essay, defense of the project, an analytical review and others. Tasks of design and research character).

RK: \_2

Intermediate control: exam during the examination session.

Boundary control is carried out on the theoretical and practical issues within the content of the subjects (7, 8 weeks).

Consultations on the subjects of the module can be obtained during office hours of the teacher (SWSL).

Criteria for assessing the knowledge and skills, in% points

**Шкала оценки знаний:**

|  |  |  |  |
| --- | --- | --- | --- |
| Оценка по буквенной системе | Цифровой эквивалент баллов | %-ное содержание | Оценка по традиционной системе |
| А | 4,0 | 95-100 | Отлично |
| А- | 3,67 | 90-94 |
| В+ | 3,33 | 85-89 | Хорошо |
| В | 3,0 | 80-84 |
| В- | 2,67 | 75-79 |
| С+ | 2,33 | 70-74 | Удовлетворительно |
| С | 2,0 | 65-69 |
| С- | 1,67 | 60-64 |
| D+ | 1,33 | 55-59 |
| D- | 1,0 | 50-54 |
| F | 0 | 0-49 | Неудовлетворительно |
| I  (Incomplete) | - | - | «Дисциплина не завершена»  (*не учитывается при вычислении GPA)* |
| P  (Pass) | **-** | **-** | «Зачтено»  (*не учитывается при вычислении GPA)* |
| NP  (No Рass) | **-** | **-** | «Не зачтено»  (*не учитывается при вычислении GPA)* |
| W  (Withdrawal) | - | - | «Отказ от дисциплины»  (*не учитывается при вычислении GPA)* |
| AW  (Academic Withdrawal) |  |  | Снятие с дисциплины по академическим причинам  (*не учитывается при вычислении GPA)* |
| AU  (Audit) | - | - | «Дисциплина прослушана»  (*не учитывается при вычислении GPA)* |
| Атт. |  | 30-60  50-100 | Аттестован |
| Не атт. |  | 0-29  0-49 | Не аттестован |
| R (Retake) | - | - | Повторное изучение дисциплины |

**Policy of academic conduct and ethics**

Be tolerant and respect the opinions of others. Objection was formulated in the correct form. Plagiarism and other forms of unfair work unacceptable. Unacceptable prompting and cheating while putting CDS intermediate control and examination, copying solved problems others, exam for another student. Student convicted of falsification of any information of the course will receive a final evaluation of «F».

*Considered at the meeting of the Department*

*Protocol № \_\_ from "\_\_" \_\_\_\_\_\_\_\_\_\_\_ of*