AL-FARABI KAZAKH NATIONAL UNIVERSITY

FACULTY OF PHYSICS AND TECHNIQUES

CHAIR OF SOLID STATE PHYSICS AND NONLINEAR PHYSICS

**SYLLABUS
SPRING SEMESTER, 2016/2017 ACADEMIC YEAR**

**Academic course information**

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| --- | --- | --- | --- | --- | --- |
| Discipline’s code | Discipline’s title | Type | No. of hours per week | Number of credits | ECTS |
| Lect. | Pract. | Lab. |
| PPS 5308 | Design of Photoconverter Devices | BC  | 1 | 1 | 1 | 3 | 5 |
| Lecturer | Sagidolda Yerulan, PhD, Senior Lecturer | Office hours | Scheduled |
| e-mail | E-mail: Erulan.Sagidolda@kaznu.kz |
| Telephones | Telephone: +7 707 459 9325 | Auditory | 104 |

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| --- | --- |
| Academic presentation of the course | **Type of course** Theoretical and practical; Elective. Its purpose to receive information in design of sensor devices at a nanoscale. This course is the one of the main part of educational program:**The aim of the course:** to form a system of competences in the context of qualification requirements:**Cognitive competence:****Knowledge.** basic theory and practical application of nanoelectronic devices such as quantum dots, quantum wells and wires, nanocapacitors, nanodiodes and nanotransistors.**Understanding.** To classify the nanomaterials for electronics, to understand that the silicon technologies are one of most preferable energy sources.**Functional competence:****Application.** be able to consider new problems of nanoelectronics practiced on project oriented lessons; able to act autonomously within agreed guidelines.**Analysis.** be able to analyze a choice of skills and practical implementation of using and obtaining nanoelectonic devices;**System competence:****Synthesis.** be able to use basic skills of nanotechnologies and nanomaterials in nanoelectronics;**Evaluation.** be able to appropriate scientific technical and reference books.**Social competence:****Willingness to cooperate:** To formulate and to express own idea to team, to explain problems in producing nanosensors and to find its solutions.**Metacompetence:** **Skills in the field of education.** Objective evaluation of achievements during study of discipline, identify producing of nanosensors as for further personal and professional development. |
| Prerequisites  | “Microelectronics”, “Optoelectronics”, “Semiconductor Electronics”, “Circuit technics”. |
| References and Resources | Required1. Ignatov A., Fadeeva N., Savinykh V. Classical Electronics & Nanoelectronics. M:, FLINTA. – 2012. – 723 p. (rus)2. M.K.Ibraimov, Y. Sagidolda, S.L. Rumyantsev, Z.Zh. Zhanabaev, M.S. Shur. Selective Gas Sensor Using Porous Silicon // Sensor Letters.3. Z.Z. Zhanabaev, T.Yu. Grevtseva, Y. Sagidolda, M.K. Ibraimov, A.G. Khamzina. Morphology of porous silicon with vertical nanowires// NanoOstrava– 4th Nanomaterials and Nanotechnology Meeting, Czech Republic, May 18-21, 2015, pp.102-103. ISBN 978-80-248-3745-1.4. Z.Z. Zhanabaev, T.Yu. Grevtseva, M.K. Ibraimov, Y. Sagidolda, A.G. Khamzina. Electrical properties of nanoscale silicon wires // NanoOstrava– 4th Nanomaterials and Nanotechnology Meeting, Czech Republic, May 18-21, 2015, p.104. ISBN 978-80-248-3745-1.Recommended1. Fahrner W. Nanotechnology and Nanoelectronics. Springer-Verlag Berlin Heidelberg. – 2005. – 270 p. (English)2. Wang Z.L. Nanowires and Nanobelts. Springer US. -2003. – 475 p. (English)3. Xi N., Lai K. Nano Optoelectronic Sensors and Devices. William Andrew. – 2016. 224 p. (English)Internet resources: Additional study material for homework and projects will be available on your page on univer.kaznu.kz in EMCD section. |
| Academic policy of the course in the context of university moral and ethical values | **Academic Behaviour Rules:** Compulsory attendance in the classroom, the impermissibility of late attendance. Without advance notice of absence and undue tardiness to the teacher is estimated at 0 points.Submission of assignments (Independent work of students, midterm control, laboratory tasks, projects and etc.) prior to the deadlines. The violation of submission deadlines leads to the deduction of penalty points.**Academic values:** Academic honesty and integrity: independent performance of assignments; inadmissibility of plagiarism, forgery, cheating at all stages of the knowledge control, and disrespectful attitude towards teachers. (The code of KazNU Student’s honor) Students with disabilities may receive advice via Erulan.Sagidolda@kaznu.kz E- address, phone 87074599325 |
| Evaluation and attestation policy | **Criteria-based evaluation:** Classroom assignments 25%Independent research 35%Examinations 40% Total 100% **Summative evaluation:** Your final score will be calculated by the formula:The final grade on discipline =$\frac{BC1+BC2}{2}∙0,6+0,1МТ+0,3TC$Below are minimum estimates Percentage:95% - 100%: А 90% - 94%: А-85% - 89%: В+ 80% - 84%: В 75% - 79%: В-70% - 74%: С+ 65% - 69%: С 60% - 64%: С-55% - 59%: D+ 50% - 54%: D- 0% -49%: F |
| Calendar (schedule) the implementation of the course content (Appendix 1) | Weekly description of lecture topics, practical / seminar / laboratory / project work , assignments for independent work of students; an indication of the topic scope and grading scheme, including an assessment of the control task. Summary and analysis of the curriculum content after the first half of the semester (midterm control 1) in the form of a scientific essay / system-oriented analysis of scientific issues of studied topics / presentation of individual case studies / evaluation of personal contribution to the development of a group project assignment, and others. |

Lecturer Sagidolda Ye.

Head of the Chair Yar-Mukhamedova G.

Chairman of the Faculty Methodical Bureau Gabdullina G.

Dean of Faculty Davletov A.

**APPENDIX 1**

**Calendar (schedule) the implementation of the course content:**

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| --- | --- | --- | --- |
| Week / date | Topic title (lectures, practical classes, Independent work of students) | Number of hours | Maximum score |
| 1 | 2 | 3 | 5 |
| 1 | Lecture 1. Introduction. Nanoelectronics and Nanotechnology.Practical class 1. Recent advances in nanoelectronics.Laboratory works 1. Study of the spectral characteristics of silicon based sensors. |  |  |
| 2 | Lecture 2. Nanostructured materials. Nanoclusters.Practical class 2. Cluster structure of solids.Laboratory works 2. Obtaining of silicon nanostructures by electrochemical etching, part 1. |  |  |
| 3 | Lecture 3. Methods of manufacturing nanostructured silicon films.Practical class 3. The electrochemical etching of silicon films.Laboratory works 3. Laboratory works 2. Obtaining of silicon nanostructures by electrochemical etching, part 2.Independent work of student with teacher: Assignment submission 1 «Nanoelectronics today: achievements and prospects», presentation |  |  |
| 4 | Lecture 4. Nanotubes.Practical class 4. Preparation and properties of nanotubes.Laboratory works 4. Laboratory works 2. Obtaining of silicon nanostructures by electrochemical etching, part 3. |  |  |
| 5 | Lecture 5. Fullerenes. Methods for producing fullerenes.Practical class 5. Properties and applications of fullerenes.Laboratory works 5. Laboratory works 2. Obtaining of silicon nanostructures by electrochemical etching, part 4.Independent work of student with teacher: Assignment submission 1 «The use of modern forms of microscopy to study the morphology of the surface of solids», presentation |  |  |
| 6 | Lecture 6. Nanomaterials with memristive properties.Practical class 6. Hysteresis properties of nanostructures.Laboratory works 6. Estimating of porosity of porous silicon. |  |  |
| 7 | Lecture 7. Methods of forming silicon nanowires.Practical class 7. Obtaining of silicon films by MACE method.Laboratory works 7. Obtaining silicon nanowires by metal-assisted chemical etching, part 1.Independent work of student with teacher: Assignment submission 1 «Methods of assessment of degree of porosity silicon Nanofilms», presentation |  |  |
|  | Boundary Control 1 |  | 100 |
| 8 | Lecture 8. THz emitters.Practical class 8. Manufacturing methods of Terahertz emitters.Laboratory works 8. Obtaining silicon nanowires by metal-assisted chemical etching, part 2. |  |  |
|  | Midterm |  | 100 |
| 9 | Lecture 9. Terahertz detectors.Practical class 9. Real-time THz receivers.Laboratory works 9. Obtaining silicon nanowires by metal-assisted chemical etching, part 3.Independent work of student with teacher: Assignment submission 1 «Modern memristive devices. The using of Terahertz electromagnetic waves», presentation |  |  |
| 10 | Lecture 10. Integrated circuits.Practical class 10. Methods of manufacturing integrated circuits.Laboratory works 10. Obtaining silicon nanowires by metal-assisted chemical etching, part 4. |  |  |
| 11 | Lecture 11. Sensors on FET.Practical class 11. Evaluation 4S sensor characteristics.Laboratory works 11. Preparation of gas sensor devices from silicon nanowires and porous silicon.Independent work of student with teacher: Assignment submission 1 «Fabrication of integrated circuits using lithography», presentation |  |  |
| 12 | Lecture 12. Gas sensors based on graphene structures.Practical class 12. The recovery time of the sensor after exposure.Laboratory works 12. Deposition of metal contacts on porous silicon and silicon nanowire’s surfaces, part 1. |  |  |
| 13 | Lecture 13. Gas sensors based on porous silicon.Practical class 13. Effect of the degree of porosity in the silicon sensor sensitivity.Laboratory works 13. Deposition of metal contacts on porous silicon and silicon nanowire’s surfaces, part 2.Independent work of student with teacher: Assignment submission 1 «Industrial types of gas sensors», presentation |  |  |
| 14 | Lecture 14. Gas sensors based on silicon nanowires.Practical class 14. Physical adsorption.Laboratory works 14. Evaluation of silicon nanostructured gas sensors as an ethanol sensor. |  |  |
| 15 | Lecture 15. Biological and chemical sensors based on nanostructures.Practical class 15. The physical characteristics of the gas sensors.Laboratory works 15. Evaluation of silicon nanostructured gas sensors as a toluene sensor.Independent work of student with teacher: Assignment submission 1 «Physical properties of gas sensors», presentation |  |  |
|  | Boundary Control 2 |  | 100 |
|  | Exam |  | 100 |
|  | Total |  | 100 |

**APPENDIX 2**

**DESCRIPTION**

of the expected learning outcomes as the system of formed competences

 (on the Dublin descriptors).

А) a short summary of the competence content, B) verbs to formulate the content of competence in the discipline, identify methods, techniques, types of tasks, aimed at the formation of these competencies; define the typology of examination tasks and questions are given in brackets.

**Cognitive competence:**

**Knowledge.** [А) memorization and reproduction of learned material – from the specific facts to a complete theory; B) *know, organize, identify, repeat, fill in the tables, remember, name, organize, recognize, relate, recall, repeat, reproduce; make a list, select, tell, show.*]

**Understanding.** [А) the ability to convert material from one form of expression - into another, interpret information, to express assumption about the future course of occurances, events; B) *classify, describe, identify characteristics, discuss, explain, express, certify, find, recognize, report, restate, review, select, translate*.]

**Functional competence:**

**Application.** [А) ability to apply learned material in specific circumstances and new situations; B) *apply, choose, demonstrate, dramatize, illustrate, interpret, operate, practice, develop a schedule / sketch, solve, use, write.*]

**Analysis.** [А) the ability to separate parts of the integrity; identify the relationship between them; define the organization principles of the integrity; carry out a distinction between facts and consequences; evaluate the importance of the data; B) *analyze, evaluate, calculate, classify, compare, criticize, differentiate, differ, distinguish, examine, experiment, reveal the similarities and differences, clarify the parameters, check*.]

**System competence:**

**Synthesis.** [ А) the ability to combine elements to get integrity with novelty, (essay, presentation, report, project, case, quest, and others.); B) *organize, gather, collect, compile, build, create, develop, formulate, prove point of view, manage, organize, plan, predict, prepare, propose, create, write.*]

**Evaluation.** [А) ability to assess the value of one or another particular material, the logic of information, construction of the text, compliance with conclusions, importance of activity outcome; B) *evaluate, discuss, pertain, choose, compare, defend, evaluate, judge, predict, select, maintain, defend a point of view, prove, predict, submit argument*.]

**Social competence:**

**Willingness to cooperate:** A) to provide with information, ideas, problems and solutions, work in a team; B) *to formulate (problem, purpose, objectives, conclusions, conditions, etc.); to define (requirements, criteria, guidelines); make decisions and report them to make conclusions, give argumentation, to justify, to insist, to persuade, etc..*

**Metacompetence:**

**Skills in the field education.** [A) to develop skills essential to continue education with a high degree of autonomy; B) *Being able to reflection, objective evaluation of their achievements; realize necessity of new competencies; identify areas for further personal and professional development, and others.* **]**