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**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 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 |
| Assistant | Mukhametkali Baurzhan, MSc, Senior Lecturer | Office hours | Scheduled |
| e-mail | E-mail:  |
| Telephones | Telephone:  | Auditory | 202 |

|  |  |
| --- | --- |
| Academic presentation of the course | **Type of course** Theoretical and practical; Elective. Its purpose to receive information in design of photoconverter devices. 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.** Clearly identify simple photoconvertors, its working principles, its properties and efficiency. To know basic requirements in designing photoconvertors.**Understanding.** To classify the alternative sources of energy, to understand that the solar energy is the one of most preferable energy sources.**Functional competence:****Application.** To apply received knowledge in practice, in fabrication of solar cells. To operate with all solar panels.**Analysis.** To evaluate the efficiency of different solar panels, to find its distinguish, to calculate of efficiency of silicon solar cells and GaAs solar cells and to examine its tolerance to external influence **System competence:****Synthesis.** To develop the new complex types of solar cells, to predict the efficiency of obtained new solar panels.**Evaluation.** To evaluate the efficiency of chosen method for obtaining new solar cells, to discuss the famous methods of obtaining solar cells, to select most effective method. **Social competence:****Willingness to cooperate:** To formulate and to express own idea to team, to explain problems in producing solar cells and to find its solutions.**Metacompetence:** **Skills in the field of education.** Objective evaluation of achievements during study of discipline, identify producing of photoconvertors as for further personal and professional development. |
| Prerequisites  | “Semiconductor electronics”, “Optoelectronics”. |
| References and Resources | 1. Solar Electricity Handbook 2014: A Simple Practical Guide to Solar Energy - Designing and Installing Photovoltaic Solar Electric Systems Paperback – Import, 9 Dec 2013, by Michael Boxwell (Author), Sheila Glasbey (Editor)2. Solar Energy Engineering: Processes and Systems Hardcover – Import, 11 Jan 2014, by Soteris A. Kalogirou Dr. (Author)3. Photovoltaic Design and Installation For Dummies Paperback – 3 Sep 2010, by Ryan Mayfield (Author)4. Photovoltaics: Design and Installation Manual Paperback – Import, 26 Aug 2004, by "Solar Energy International" (Author)5. Let it Shine: The 6,000-Year Story of Solar Energy Hardcover – Import, 16 Oct 2013, by John Perlin (Author)6. Solar Energy: Technologies and Project Delivery for Buildings (RSMeans) Hardcover – Import, 5 Nov 2013, by Andy Walker (Author)Internet resources: 1. <http://pveducation.org/>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.

Assistant Mukhametkali B.

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:**

|  |  |  |  |
| --- | --- | --- | --- |
| Week / date | Topic title (lectures, practical classes, Independent work of students) | Number of hours | Maximum score |
| 1 | 2 | 3 | 5 |
| 1 | Lecture 1. Introduction. The photodetectors.Practical class 1. Photodetector with an internal emissions.Laboratory works 1. Study of the spectral characteristics photoconverter. |  |  |
| 2 | Lecture 2. General principles for the direct conversion of solar energy into electricity.Practical class 2. Basic materials of the solar cells.Laboratory works 2. The compound of solar cells. |  |  |
| 3 | Lecture 3. Photoelectric converters: their types and characteristics.Practical class 3. Types of solar cells.Laboratory works 3. The parallel connection of solar cells.Independent work of student with teacher: Assignment submission 1 «Economic and environmental conditions of use of renewable energy resources», presentation |  |  |
| 4 | Lecture 4. Main characteristics of photoelectric converters, conversion efficiency.Practical class 4. Calculation of characteristics photoconverter.Laboratory works 4. The series connection of solar cells. |  |  |
| 5 | Lecture 5. Nanocomponents and nanomaterials for photoelectric conversion.Practical class 5. Quantum-dimensional photodetectors.Laboratory works 5. Analysis of the output parameters of the solar batteries.Independent work of student with teacher: Assignment submission 1 «Spectral and energy components of solar radiation and the effect of the Earth's atmosphere on the radiant energy flows», presentation |  |  |
| 6 | Lecture 6. IR photodetectors.Practical class 6. Spectral ranges of IR photodetectors.Laboratory works 6. The calculation of the current-voltage characteristics of the solar cell and battery. |  |  |
| 7 | Lecture 7. The assembly technology of photoelectronic devices.Practical class 7. The photodiodes and phototransistors.Laboratory works 7. Determining the size of the required solar cell area.Independent work of student with teacher: Assignment submission 1 «Solar rating on the Earth's surface and analyzes the methods of measurement», presentation |  |  |
|  | Boundary Control 1 |  | 100 |
| 8 | Lecture 8. Electrical connections of solar cells and batteries.Practical class 8. The calculation of the efficiency of solar cells.Laboratory works 8. Construction of interconnections applied in practice. |  |  |
|  | Midterm |  | 100 |
| 9 | Lecture 9. The main stages of development of contact connections of solar cells.Practical class 9. The main causes of the destruction of solar cells and inter-element wiring.Laboratory works 9. Circuit simulation of solar cells.Independent work of student with teacher: Assignment submission 1 «Physical principles of Heliothermal energy converters», presentation |  |  |
| 10 | Lecture 10. Manufacture, measurement parameters and testing of solar panels.Practical class 10. Methods for measuring the performance of solar cells.Laboratory works 10. Circuit simulation of solar cells. |  |  |
| 11 | Lecture 11. Exploitation of solar panels.Practical class 11. Precautions for the manufacture and assembly.Laboratory works 11. The method of the measurement of light sensitivity.Independent work of student with teacher: Assignment submission 1 «Optical properties of materials for solar radiation detectors and heat shields», presentation |  |  |
| 12 | Lecture 12. Methods for improving the efficiency of solar cells.Practical class 12. Calculation of efficiency.Laboratory works 12. Measurements of Performance of photocell. |  |  |
| 13 | Lecture 13. Concentrating solar panels.Practical class 13. Calculation of the aperture.Laboratory works 13. The planar solar concentrator.Independent work of student with teacher: Assignment submission 1 «Tthermal solar systems for cooling, for heating and drying the air», presentation |  |  |
| 14 | Lecture 14. Automatic System of the solar battery orientation.Practical class 14. An analysis of the angular distribution of the photo-emf.Laboratory works 14. Power management unit for solar cells. |  |  |
| 15 | Lecture 15. Automated PV installation with increased energy efficiency.Practical class 15. Расчет системы автоматического регулирования.Laboratory works 15. Using microcontrollers in system management solar tracker.Independent work of student with teacher: Assignment submission 1 «The dependence of efficiency by photocell parameters, temperature characteristics of solar cell, the spread parameters and schematics», 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.* **]**