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**Project 561525-EPP-1-2015-1-LV-EPPKA2-CBHE-JP**  
**Improvement of master-level education in the field**  
**of physical sciences in Belarusian universities**  
**15/10/2015 – 14/10/2018**

**WP2: Development and Modernizing of Curricular**

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## **WP2: “Development and modernizing of curricula“**

### **Goal of presentation:**

- **Objectives of the WP2 at the 1-st activity period**
- **Where higher education in Belarus is going**
- **Description of WP2 results and deliverables**
- **Resume**



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## **WP2: “Development and modernizing of curricula“**

# **Objectives of the WP2 at the 1-st activity period**



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## **WP2: “Development and modernizing of curricula“**

### **Main objectives of the WP2:**

- **to upgrade curricula in physical sciences in four universities of Belarus according to Bologna practices,**
- **to enhance the quality and relevance of education by modernising study programs, through the enhanced use of ICT and networking activities to the labour market needs.**



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## **WP2: “Development and modernizing of curricula“**

**Main results of WP2 during the 1<sup>st</sup> activity period:**

- Development of *curricula drafts* in accordance to labour market needs basing on Bologna practices;
- Development of Contents of two e-Books for upgrading master-level education in the field of physical sciences for specialties:  
    **Functional Nanomaterials,**  
    **Photonics.**
- Readiness for transition from existing “5 + 1” system of education *to a new training system “4 + 2”* (4 years for bachelors and 2 years for master level study)



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**WP2: “Development and modernizing of curricula“**

**Where Higher Education in Belarus  
is going?**



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## **WP2: “Development and modernizing of curricula“**

**Before 2014, training process for students of BSU, BSTU, GoSU and GrSU was constructed using mainly 3-stage education system “5 + 1 + 3” by all Specialities both in Physical Sciences and Engineering.**



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**FIRST DEGREE of  
HIGHER EDUCATION (4 year)**

**Specialities:**  
Functional nanomaterials  
Fotonics  
Fundamental physics  
Computer simulation physics

**Qualifications:**  
- «Physicist. Engineer»  
- «Physicist. Manager»

**Holder of Diploma “Diplomaed  
specialist”**



**SECOND DEGREE of  
HIGHER EDUCATION (2 year)**

Functional nanomaterials  
Fotonics  
Fundamental physics  
Computer simulation physics

**Holder of a master's degree**



**PhD STUDENTSHIP (3 years)**

**Branches of Science:**  
01.04 - Physics and Mathematics  
(in specialities)

**Holder of PhD degree in physics  
and mathematics**

**Striving to reform Belarusian high education system according to the Bologna process, since academic year 2014-2015 Belarusian Ministry of Education set the target *for the most HEIs to reform curricula from the existing system* **“5 + 1 + 3”** **to the system** **“4 + 2 + 3”**.**

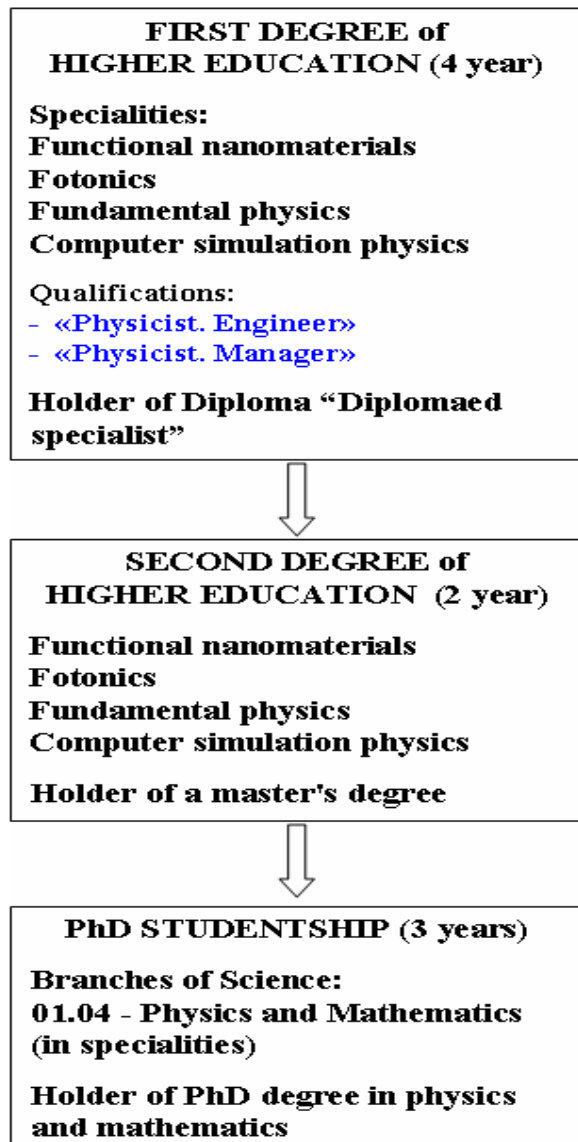
**Fig. 1. The flowchart for some specialities in Physics in BSU since 2013-2014 educational year**





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So, to realize the possibility of continuing education at the Master Level Stage for individuals trained on the Bachelors Stage, now we have the goal to develop curricula and related documentation for specialties “Functional Nanomaterials” and “Photonics”, taking into account the experience of the EU countries and the desire of Belarus to join the European Space of Higher Education.

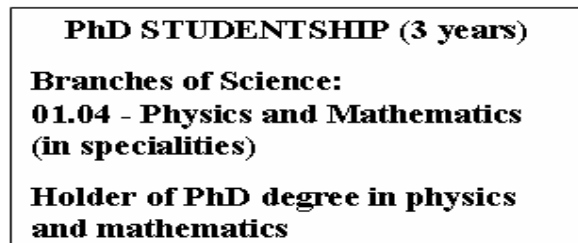
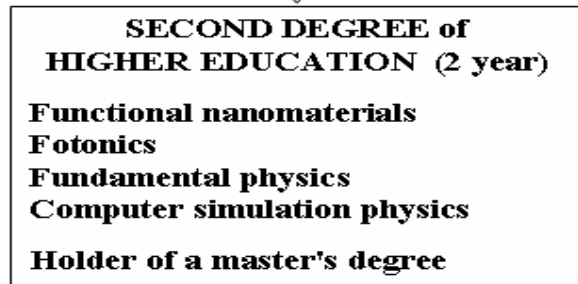
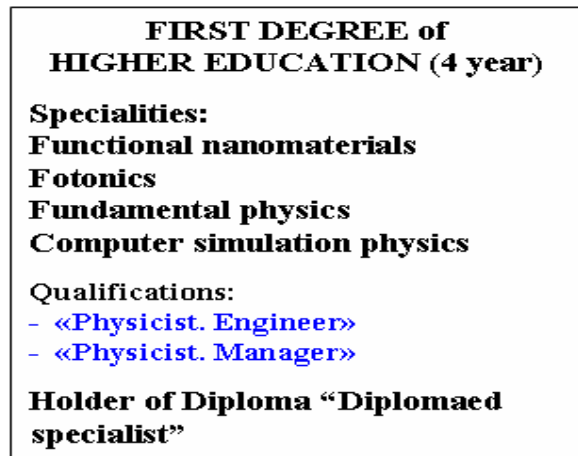
The choice of specialties is due to the need for Research Institutions and Hi-Tech enterprises of Belarus in highly qualified specialists of this profiles.

**Fig. 1. The flowchart for some specialties in Physics in BSU since 2013-2014 educational year**



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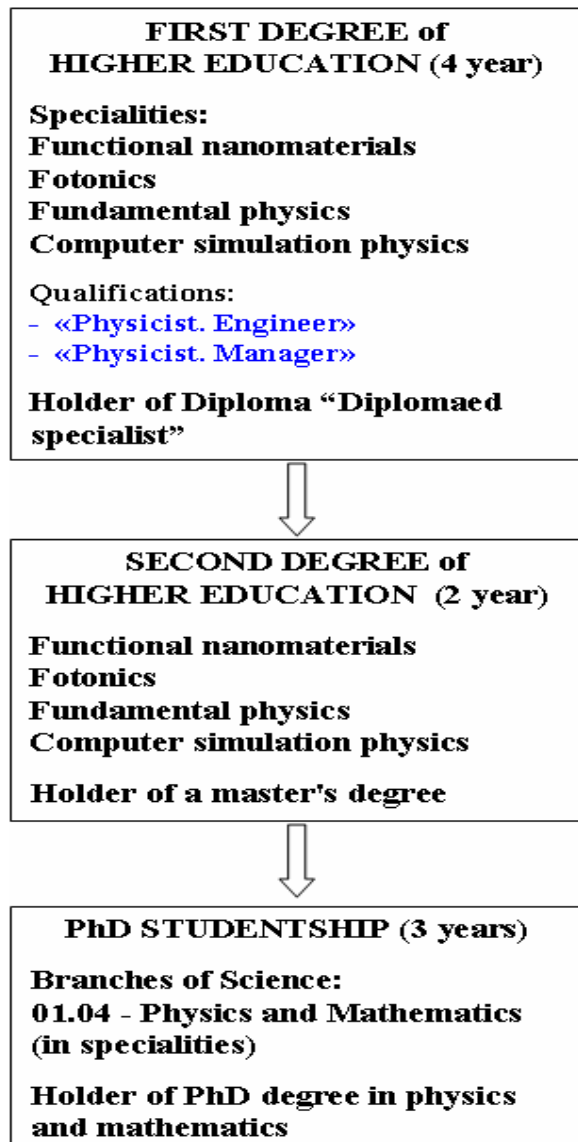
- The developed Curricula should provide:**
- 1. Minimizing of losses in the context of pre-existing 5+1 system;**
  - 2. A high level of basic training graduates of the Stage I in mathematics and physics;**
  - 3. The possibility of in-depth specialization in the Master Level Stage;**
  - 4. Extensive training in Applied Physics to enhance staff potential of industrial enterprises;**
  - 5. The possibility of practical training both for research and industrial sectors;**

**Fig. 1. The flowchart for some specialities in Physics in BSU since 2013-2014 educational year**



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**The developed Curricula should provide:**

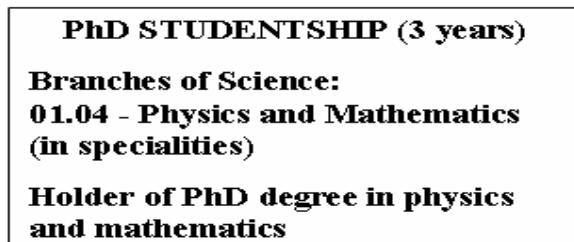
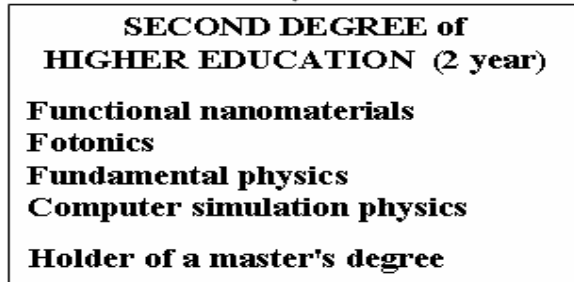
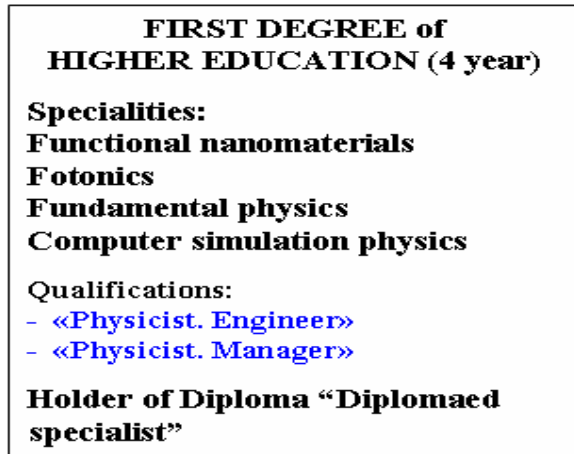
6. The conditions for maintaining the high scientific level of master's theses;
7. Variability of in-depth specialization during the Master Level Stage, using not only disciplines of the State (Mandatory) and University Components but also elective courses by the choice of students;
8. Possibilities to develop export of services in the field of higher education improving trainings in English.

**Fig. 1. The flowchart for some specialities in Physics in BSU since 2013-2014 educational year**



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**The developed Curricula for 2-years Master-level programmes for specialties “Photonics” and “Functional Nanomaterials” will have the following distribution of educational work:**

- A set of special training courses - 56-68 %
- Research work - 15-20 %
- Practices - 4-12 %
- Final examination - 7-10 %

**In so doing, we expect to provide some elective disciplines by the choice of a students containing about 20 to 50 % of the number of training courses.**

**Fig. 1. The flowchart for some specialities in Physics in BSU since 2013-2014 educational year**



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**Holder of a master's degree**



**PhD STUDENTSHIP (3 years)**

**Branches of Science:**  
01.04 - Physics and Mathematics  
(in specialities)

**Holder of PhD degree in physics  
and mathematics**

**Additional tasks for matching  
of education in Belarus with  
Bologna principles:**

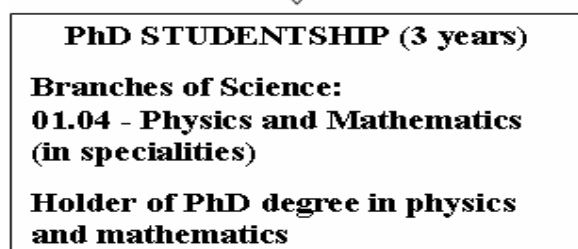
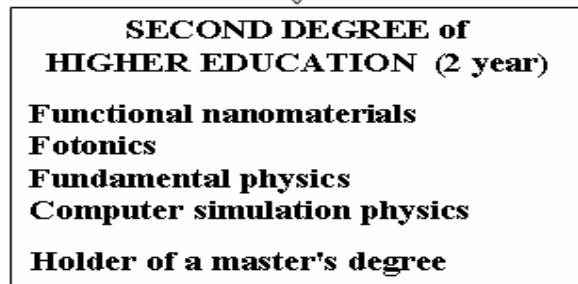
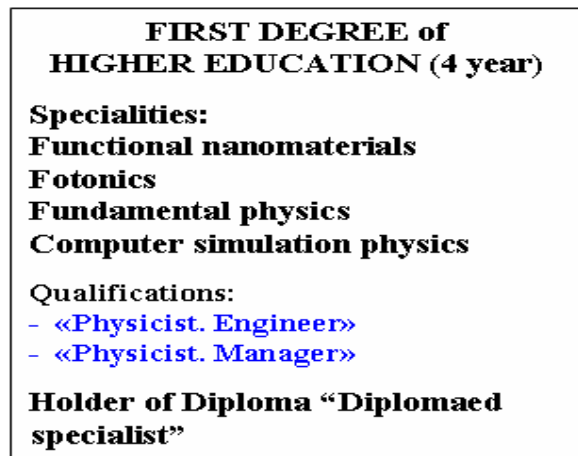
- 1. Transition to cycle system,**
- 2. Credit transfer,**
- 3. Internationalization of  
education,**
- 4. Usage of ECTS standards,**
- 5. Etc.**

**Fig. 1. The flowchart for some specialities in Physics in BSU  
since 2015-2016 educational year**



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In respect to specific needs, identified above, ***the target is:***

- to upgrade Master-level education (Stage II) in the field of functional nanomaterials and photonics,
- to enhance the quality and relevance of education using modernised study programs,
- focusing on the use of ICT,
- taking into account the labour market needs.

**Fig. 1. The flowchart for some specialities in Physics in BSU since 2015-2016 educational year**



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## **WP2: “Development and modernizing of curricula“**

### **Description of WP2 results and deliverables**



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## **WP2: “Development and modernizing of curricula“**

**Preliminary Curricula for 2-year Master-Level Stage by specialty “Functional nanomaterials” includes:**

- **list of courses (see, below);**
- **their short content;**
- **number of hours and**
- **some other information.**





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## **WP2: “Development and modernizing of curricula“**

**The Preliminary list of courses is divided on 3 parts (components):**

- State (mandatory) component,**
- University component and**
- Courses at students` option.**



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## **WP2: “Development and modernizing of curricula“**

### **Preliminary list of courses (State component)**

<i>Year</i>	<i>Semester</i>	<i>Title of special course</i>
<i>1</i>	<i>2</i>	Nanostructured materials and their testing methods



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## **WP2: “Development and modernizing of curricula“**

### **Preliminary list of courses (University component)**

<i>Year</i>	<i>Semester</i>	<i>Title of special course</i>
<i>1</i>	<i>1</i>	Contemporary presentation of matter structure
<i>1</i>	<i>1</i>	Additional chapters of quantum mechanics
<i>1</i>	<i>1</i>	Physics of condensed matter
<i>1</i>	<i>1</i>	Group theory
<i>1</i>	<i>2</i>	Problemes of applied physics
<i>1</i>	<i>2</i>	Wave processes physics
<i>1</i>	<i>2</i>	Non-linear physics
<i>1</i>	<i>2</i>	Physics and chemistry of surface
<i>1</i>	<i>2</i>	Low dimensional systems (LDS)
<i>1</i>	<i>2</i>	Optics of nanostructures
<i>2</i>	<i>3</i>	Theory of transfer



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## **WP2: “Development and modernizing of curricula“**

### **Preliminary list of courses (by students` choice)**

<i>Year</i>	<i>Semester</i>	<i>Title of special course</i>
1-2	1-3	Materials and electronic structures in energetics
2	3	Nanomaterials and nanostructures in electronics
2	3	Synthesis of nanomaterials
2	4	Nanotechnology in electronics
2	4	Special chapters of LDS
2	4	Bionanomaterials/Physics of liquid crystals
2	4	Spectra and structure of molecules
2	4	Technique of microcontroller systems
2	4	Laser physics
2	4	Polymer physics



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On the basis of compatible types of training programs, providing lecture courses, laboratory sessions, etc., ***the following e-Books will be developed*** in English and translated into Russian:

<b>Course title</b>	<b>Lider</b>	<b>Participants</b>
<b>Applied Physics</b>	<b>KU Leuven (Belgium) Prof. R. De-Craemer</b>	<b>RTU, BSU, BSTU, GrSU, GoSU</b>
<b>Applied Informatics</b>	<b>Riga Technical University (Latvia) Prof. N. Kunicina</b>	<b>RTU, UCY, KU Leuven, BSU</b>
<b>Photonics</b>	<b>Belarusian State University (Belarus) Prof. A. Tolstik</b>	<b>BSU, RTU, GRSU, GoSU,</b>
<b>Functional nanomaterials</b>	<b>Belarusian State University (Belarus) Prof. A. Fedotov</b>	<b>GoSU, GrSU, BSTU, KU Leuven</b>
<b>Research towards master thesis/management of scientific projects</b>	<b>University of Cyprus (Cyprus) Prof. E. Kyriakides</b>	<b>KU Leuven, RTU, BSU, GrSU, GoSU</b>



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## **Content of e-Book “Functional nanomaterials”**

<b>Chapters/Papers</b>	<b>University</b>	<b>Contributors</b>
Executive summary	BSU	A. Fedotov, V. Odzhaev
Introduction	BSU	A. Fedotov, V. Odzhaev
Chapter 1: Concepts of Low-Dimensional Effects	BSU	A. Fedotov
Chapter 2: Introduction to Physics of Surface/Interface	BSU	A. Fedotov
Chapter 3: Thermal Properties of Nanomaterials	BSU	M. Tivanov
Chapter 4: Chemistry of Nanomaterials	BSU	A. Mazanik
Chapter 5: Physics of Carbon Low-dimensional Systems and Device Structures	BSU	N. Poklonski
Chapter 6: Arrays of carbon nanostructures: fabrication, properties and applications	BSU	V. Ksenevich
Chapter 7: Conductive Polymers	BSU	V. Odzhaev (V.Odjaev)
Chapter 8: Electrically conductive nanocomposites	BSU	N. Gorbachuk, A. Fedotov
Chapter 9: Magnetotransport and Magnetism in Nanocomposite and Multilayered Materials	BSU	J. Fedotova, J. Kasiuk



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## **Content of e-Book “Functional nanomaterials”**

<b>Chapters/Papers</b>	<b>University</b>	<b>Contributors</b>
Chapter 10: Nanoscale Materials and Structures for Spintronics	BSU	M. Lukashevich
Chapter 11: Nanomaterials for Power Engineering	BSU	A. Mazanik
Chapter 12: Nanobiomaterials	BSU	P. Bulay
Chapter 13: Fluorescent quantum dots for bioimaging	GrSU	N. Strekal
Chapter 14: Plasmonic nanomaterials for photonics, biochemistry and quantum technology	GrSU	N. Strekal
Chapter 15: Nanofibers: synthesis, properties and applications	BSTU	N.R. Prokopchuk, Zh.S. Shashok
Chapter 16: Elastomeric compositions with carbon nanomaterials	BSTU	K.V. Vishnevskii, Zh.S. Shashok
Chapter 17: Paints and coatings, modified carbon nanomaterials	BSTU	N.R. Prokopchuk et al.
Chapter 18: Plasma-chemical synthesis of nanocomposite polymer coatings	GSU	A.V. Rogachev et al.
Chapter 19: Carbon coatings doped with metals	GSU	A.V. Rogachev et al.
Chapter 20: Sol-gel synthesis of functional materials	GSU	D. Kovalenko et al.



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## **Resume**

**Thus, as a result of the project implementation, we should create an integrated, logically-connected system of complementary educational approaches and tools, allowing**

- to carry out training of the teaching/technical staff of Belarusian universities, and**

- to improve the training of master-students**

**in the physical sciences by practice-oriented master-level programme.**





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# Thank you for attention

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