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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 Implementation of Curricular:

Progress in Implementation of Curricular

Prof. A.K. Fedotov (BSU)

fedotov@bsu.by

Goal of presentation:

- **Identifying the principles of higher education in Belarus: before and after**
- **Description of WP2 implementation progress**
- **Resume**

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Identifying the principles of Higher Education in Belarus: before and after

Before 2014, training process for students of BSU, BSTU, GSU 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 (5 year)

Speciality:
1-31 04 01 - Physics (in directions)

Qualifications:
- «Physicist. Researcher»
- «Physicist. Engineer»
- «Physicist. Lecturer of physics and information science»
- «Physicist. Manager»

Holder of Diploma "Diplomaed specialist"

SECOND DEGREE of HIGHER EDUCATION (1 year)

Speciality:
1-31 04 01 - Physics (in directions)

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

In accordance with "Sertified Specialist Academic Education Programme" up to 2013-2014 education year, the training process by speciality "1-31 04 01 - Physics" was devided *on 3 stages*:

1. ***General Programme*** **for 1-4 courses (General Physics, Higher Mathematics, Theoretical Physics, etc.)**
2. ***Diploma Programme*** **for 3-5 courses (for qualifications/skill "research activity", "engineering activity" and "management activity" including 12-18 specializations).**
3. ***Three-year PhD programme*** **for the branch of science "01.04 - Physics and Mathematics" (by Specialties)**

Fig. 1. The flowchart for speciality 1-31 04 01 - Physics in BSU before 2013-2014 educational year

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

To reform Belarusian high education system according to the Bologna process, since academic year 2014-2015 *the most HEIs* passed *to the system "4 + 2 + 3".*

Fig. 2. The flowchart for some specialities in Physics in BSU since 2013-2014 educational year

WP2: Progress in Implementation of Curricular

The challenges facing curricular reform of Master-level education in Belarusian universities by the physical sciences are arisen from the analysis of the state of education system "5 + 1", made in the Ex-Ante Report.

First two points concerning the system "5 + 1"

1. The 1st stage of higher education in physical sciences was directed on decision of main tasks:

• to prepare during 5 years specialists whose skill (qualification) was enough to work in research institutes and design-centers, in Hi-Tech enterprises and to teach in universities and other HEIs.

• to give the master-students the knowledge, not only in the specialty (physics), but also by specializations (e.g., semiconductor physics, laser physics, etc.)

2. The 2nd stage of higher education (one-year master's degree) was aimed at:

• to pass the master-level exams and tests by specialty unit (physics), social and humanitarian unit (like foreign language, etc.) and ICT technologies.

• to pass two PhD-level exams that allows to attend PhD postgraduate sudentships without exams.

• preparation and defense of Master-thesis as evidence of slightly higher than a specialist qualification obtained during previous 5 years.

WP2: Progress in Implementation of Curricular

Conclusion 1:

Master-level education in Belarusian HEIs in the "5+1" system had a supporting role and actually did not gave a significant growth of qualification and skill, since all the basic knowledge and skill by specialty and specialization were obtained by students during 1st - 5th courses (on lectures, practical works, diploma thesis, etc.).

WP2: Progress in Implementation of Curricular

***Second two main points concerning the system "4+2"*:**

1. The transition to the new system radically changes the tasks for the 1st stage of higher education:

- **obtaining the diploma of specialist (or bachelor) by specialty (e.g., physics in BSU)**
- ***the practical lack of specialization***
- **possibility to enter to the masterships by specialization**

2. The transition to the new system also radically changes the tasks for the 2nd stage of higher education (master's degree):

- ***get training by specialization***

WP2: Progress in Implementation of Curricular

Conclusion 2:

Master-level education in Belarusian HEIs in the “4+2” system will give the more deepen qualification/skill as compared to bachelor level

WP2: Progress in Implementation of Curricular

Now we start to develop new curricula and training programs for specialties “Functional nanomaterials” and “Photonics”.

These documents will be based on the developed contents for five e-Books

Main short-term tasks of WP2

2.3. Five e-Books by the declared directions

Finalizing of e-Book contents

Course title	Lider	Participants
Applied Physics	KU Leuven (Belgium) Prof. Joan PEUTEMAN	RTU, BSU, BSTU, GrSU, GoSU
Applied Informatics	Riga Technical University (Latvia) Nadezhda KUNICINA	UCY, KU Leuven, BSU
Photonics	Belarusian State University (Belarus) Prof. A. Tolstik	BSU, GrSU, GSU
Functional nanomaterials	Belarusian State University (Belarus) Prof. A. Fedotov	GSU, GrSU, BSTU, KU Leuven
Guidelines on Master Thesis in Applied Physics	University of Cyprus (Cyprus) Prof. E. Kyriakides Prof. S.K. Hadjistassou	KU Leuven, RTU, BSU, GrSU, GSU

Main short-term tasks of WP2

2.3. Five e-Books by the declared directions

These e-Books developed in English and Russian will supply the basis for creation of:

- **Model curricula (education plan),**
- **Compatible training programs,**
- **Lecture courses,**
- **Laboratory practices (experimental and virtual),**
- **etc.**

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Finalized content of e-Book

Functional nanomaterials

(curator – BSU)

Functional nanomaterials
Version: 01.03.2016
The course leader: Alexander FEDOTOV - BSU

Members of group				
N	**Country**	**University**	**Group Leader**	**e-mail**
1	BY	BSU – Belarusian State University	Alexander FEDOTOV	fedotov@bsu.by
2	BY	GrSU – Grodno State University	Natalia STREKAL	nat@grsu.by
3	BY	GSU – Comel State University	Dmitry Kovalenko	vik@belstu.by;
4	BY	BSTU – Belarusian StateTechological University	N.R. Prokopchuk	vik@belstu.by
5	BE	KU – Katholik University of Loevem	Joan PEUTEMAN	joan.peuteman@kuleuven.be

Chapters/Papers	University	Contributor	Number of pages	e-Mail
Executive summary	BSU	A. Fedotov, V. Odzhaev	20	fedotov@bsu.by odzaev@bsu.by
Introduction	BSU	A. Fedotov, V. Odzhaev	5	fedotov@bsu.by odzaev@bsu.by
Chapter 1: Concepts of Low-Dimensional Effects	BSU	A. Fedotov	25	fedotov@bsu.by
Chapter 2: Introduction to Physics of Surface/Interface	BSU	A. Fedotov	20	fedotov@bsu.by
Chapter 3: Thermal Properties of Nanomaterials	BSU	M. Tivanov	20	Tivanov@bsu.by
Chapter 4: Chemistry of Nanomaterials	BSU	A. Mazanik	20	mazanikalexander@gmail.com
Chapter 5: Physics of Carbon Low-dimensional Systems and Device Structures	BSU	N. Poklonski	15	poklonski@bsu.by
Chapter 6: Arrays of carbon nanostructures: fabrication, properties and applications	BSU	V. Ksenevich	20	ksenevich@bsu.by
Chapter 7: Conductive Polymers	BSU	V. Odzhaev	15	odzaev@bsu.by
Chapter 8: Electrical conductivity of nanocomposites	BSU	N. Gorbachuk, A. Fedotov	25	gorbachuk@bsu.by

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Chapters/Papers	University	Contributor	Number of pages	e-Mail
Chapter 9: Magnetotransport and Magnetism in Nanocomposite and Multilayered Materials	BSU	J. Fedotova, J. Kasiuk	30	Julia@hep.by
Chapter 10: Nanoscale Materials and Structures for Spintronics	BSU	M. Lukashevich	15	lukashevich@bsu.by
Chapter 11: Nanomaterials for Power Engineering	BSU	A. Mazanik	20	mazanikalexander@gmail.com
Chapter 12: Nanobiomaterials	BSU	P. Bulay	25	BulayPM@bsu.by
Chapter 13. Fluorescent quantum dots for bioimaging	GrSU	N. Strekal	15	nat@grsu.by
Chapter 14: Plasmonic nanomaterials for photonics, biochemistry and quantum technology	GrSU	N. Strekal	25	nat@grsu.by
Chapter 15: Nanofibers: synthesis, properties and applications	BSTU	N.R. Prokopchuk Zh.S. Shashok	25	zhanna-shashok@mail.ru
Chapter 16: Elastomeric compositions with carbon nanomaterials	BSTU	K.V. Vishnevskii Zh.S. Shashok	20	vik@belstu.by
Chapter 17: Paints and coatings, modified carbon nanomaterials	BSTU	N.R. Prokopchuk A.L. Shutova	15	a.l.shutova@mail.ru

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Chapters/Papers	University	Contributor	Number of pages	e-Mail
Chapter 18: Plasma-chemical synthesis of nanocomposite polymer coatings	GSU	A.V. Rogachev A.A. Rogachev M. Yarmolenko	20	simmak@mail.ru
Chapter 19: Carbon coatings doped with metals	GSU	A.V. Rogachev D.Pilipcov N. Fedosenko	20	fedosenko@gsu.by
Chapter 20: Sol-gel synthesis of functional materials	GSU	D. Kovalenko V. Gaishun A. Semchenko	20	dkov@gsu.by
Chapter 21: Micro- and nanosensors	KU Leuven	Joan Peuteman	10	joan.peuteman@kuleuven.be
References				
			~400 pages	

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Preliminary content of e-Book

Photonics

(curator – BSU)

Photonics
Version: 09.03.2016
The course leader: Alexey TOLSTIK - BSU

Members of group				
N	**Country**	**University**	**Group Leader**	**e-mail**
1	BY	BSU – Belarusian State University	Alexey TOLSTIK	fedotov@bsu.by
2	BY	GrSU – Grodno State University	Natalia STREKAL	nat@grsu.by
3	BY	GSU – Comel State University		
4	BY	BSTU – Belarusian StateTechological University		
5	LV	RTU-Riga Technical University		

Preliminary content of e-Book *Photonics* (curator – BSU)

3.1. Optoelectronics and Nanophotonics (BSU)

- Semiconductor optical detectors (KU Loven, Ciprus Univ, BSU)
- Applications of photovoltaic systems (KU Loven, Ciprus Univ, BSU)
- Light flux controlling (BSU)
- Sensors (BSU)
- Photonic crystals (BSU)
- Metamaterials (GSU, BSU)
- Semiconducting and plasmonic nanoparticles (GrSU, BSU)

3.2. Laser physics and nonlinear optics

- Types of lasers and their modes of operation (BSU)
- Generation of nano- and picosecond pulses (BSU)
- Nonlinear medium and mechanisms of nonlinearity, self-focusing harmonic generation, parametric amplification and generation (BSU)
- Optics of light beams, laser resonator, laser modulation, temporary modes of lasers (GSU),
- Practical examples – lighting (RTU) (Avotins)

3.3. Coherent Optics and Holography (BSU)

- Spatial and temporal coherence
- Types of holograms: thin and volume, amplitude and phase, reflective and transmissive
- Diffraction efficiency
- Spectral and angular selectivity
- Denisyuk holograms, Fourier hologram, rainbow hologram
- Dynamic holography
- Holographic interferometry

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 programmes.

Thank you for attention

Prof. A.K. Fedotov (BSU)

fedotov@bsu.by