# Improvement of master-level education in the field of physical sciences in Belarusian universities

## WP2 Development and modernizing of curricula

Belarusian State University

# Goal of presentation:

- **Remembering of the WP2 objectives and tasks**
- **Current state of WP2**
- **Next steps**

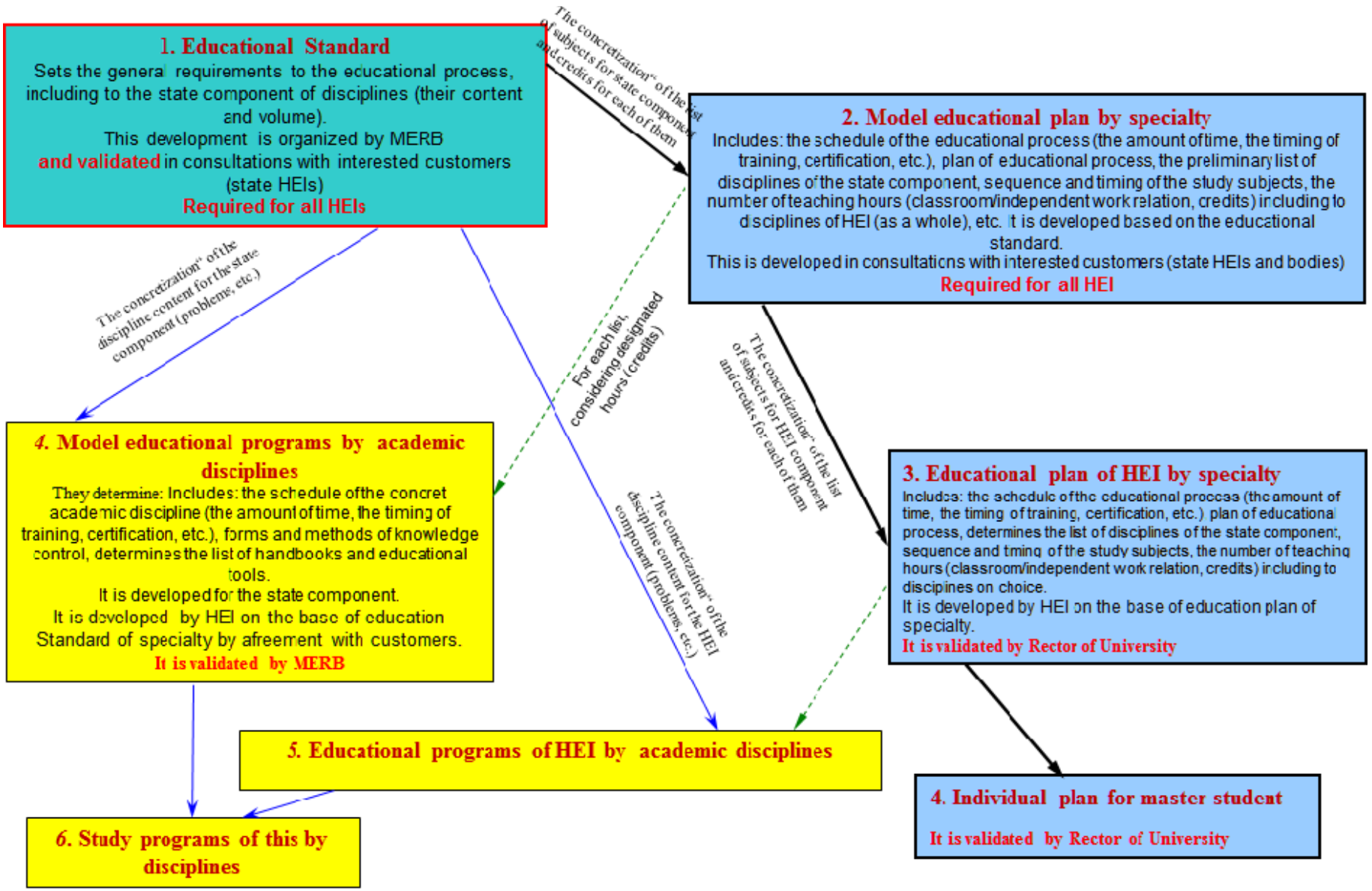
# Remembering of the WP2 tasks

- 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.

# Remembering of the WP2 tasks

- ***Development and modernizing of new muster-level curricula*** in 4 Belarusian universities;
- ***Accreditation of new master-level curricula*** in the Ministry of Education of RB (MERB);
- Belarusian universities will also provide ***internal accreditation of curricula*** in their universities;
- **5 e-Books preparation**


1. Educational Standard
Sets the general requirements to the educational process, including to the state component of disciplines (their cortent and volume).
This development is organized by MERB
and validated in consultations with interested customers (state HEIs)
Required for all HEIs
The concretization" of the list of subjects for state component and credits for each of them
2. Model educational plan by specialty
Includes: the schedule of the educational process (the amount of time, the timing of training, certification, etc.), plan of educational process, the preliminary list of disciplines of the state component, sequence and timing of the study subjects, the number of teaching hours (classroom/independent work relation, credits) including to disciplines of HEI (as a whole), etc. It is developed based on the educational standard.
This is developed in consultations with interested customers (state HEIs and bodies)
Required for all HEI
The concretization" of the discipline content for the state component (problems, etc.)
For each list, considering designated hours (credits)
The concretization" of the list of subjects for HEI component and credits for each of them
4. Model educational programs by academic disciplines
They determine: Includes: the schedule of the concret academic discipline (the amount of time, the timing of training, certification, etc.), forms and methods of knowledge control, determines the list of handbooks and educational tools.
It is developed for the state component.
It is developed by HEI on the base of education Standard of specialty by afreement with customers.
It is validated by MERB
The concretization" of the discipline content for the HEI component (problems, etc.)
3. Educational plan of HEI by specialty
Includes: the schedule of the educational process (the amount of time, the timing of training, certification, etc.) plan of educational process, determines the list of disciplines of the state component, sequence and timing of the study subjects, the number of teaching hours (classroom/independent work relation, credits) including to disciplines on choice.
It is developed by HEI on the base of education plan of specialty.
It is validated by Rector of University
5. Educational programs of HEI by academic disciplines
4. Individual plan for master student
It is validated by Rector of University
6. Study programs of this by disciplines

# Structure of curricula "Functional Nanomaterials"

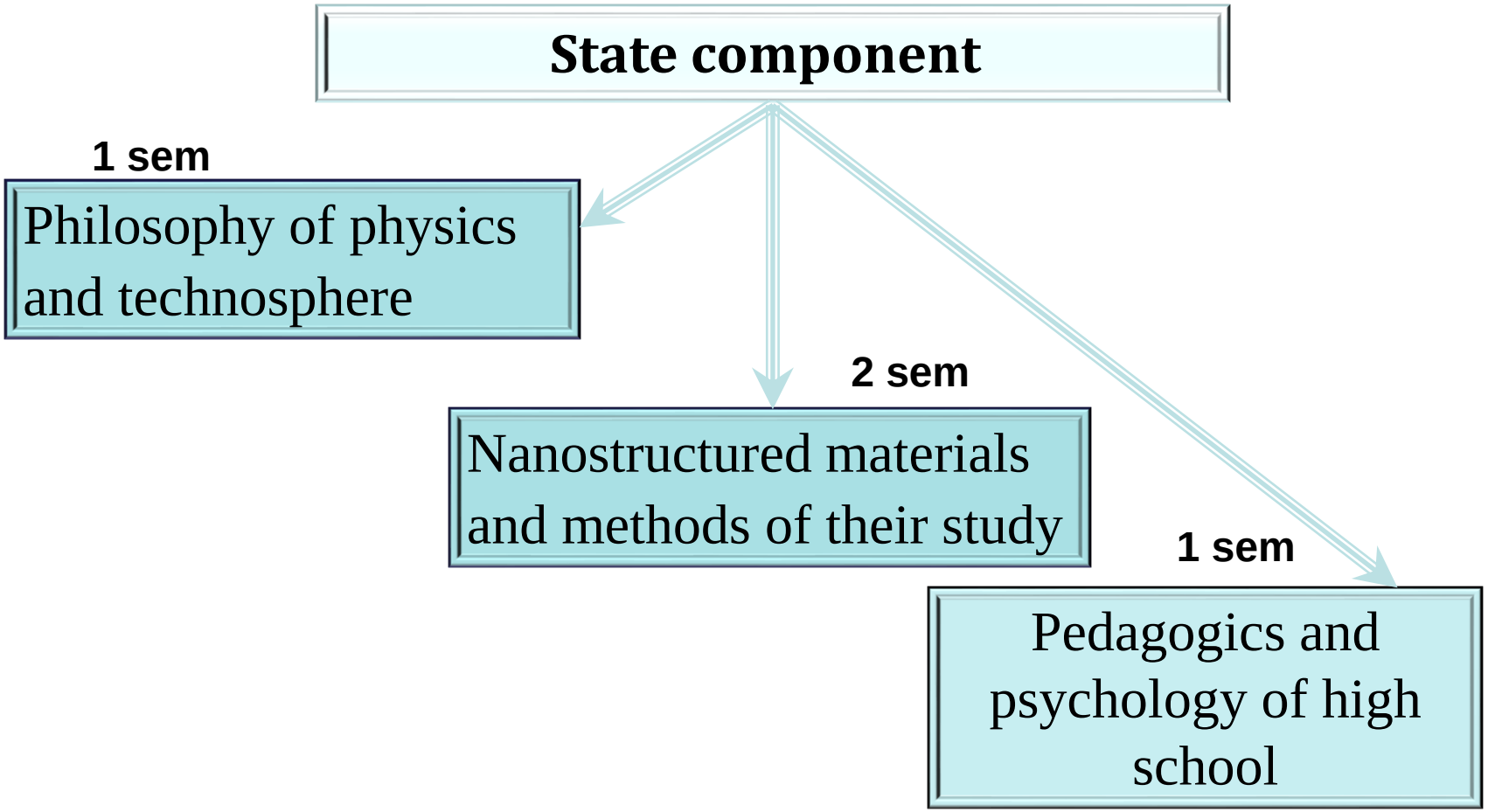
List of courses for the two-year master-level education on specialty 1-31 81 04 **FUNCTIONAL NANOMATERIALS**

**State component**

**University component**

**Elective courses/ Courses on choice**

# Structure of curricula "Functional Nanomaterials"

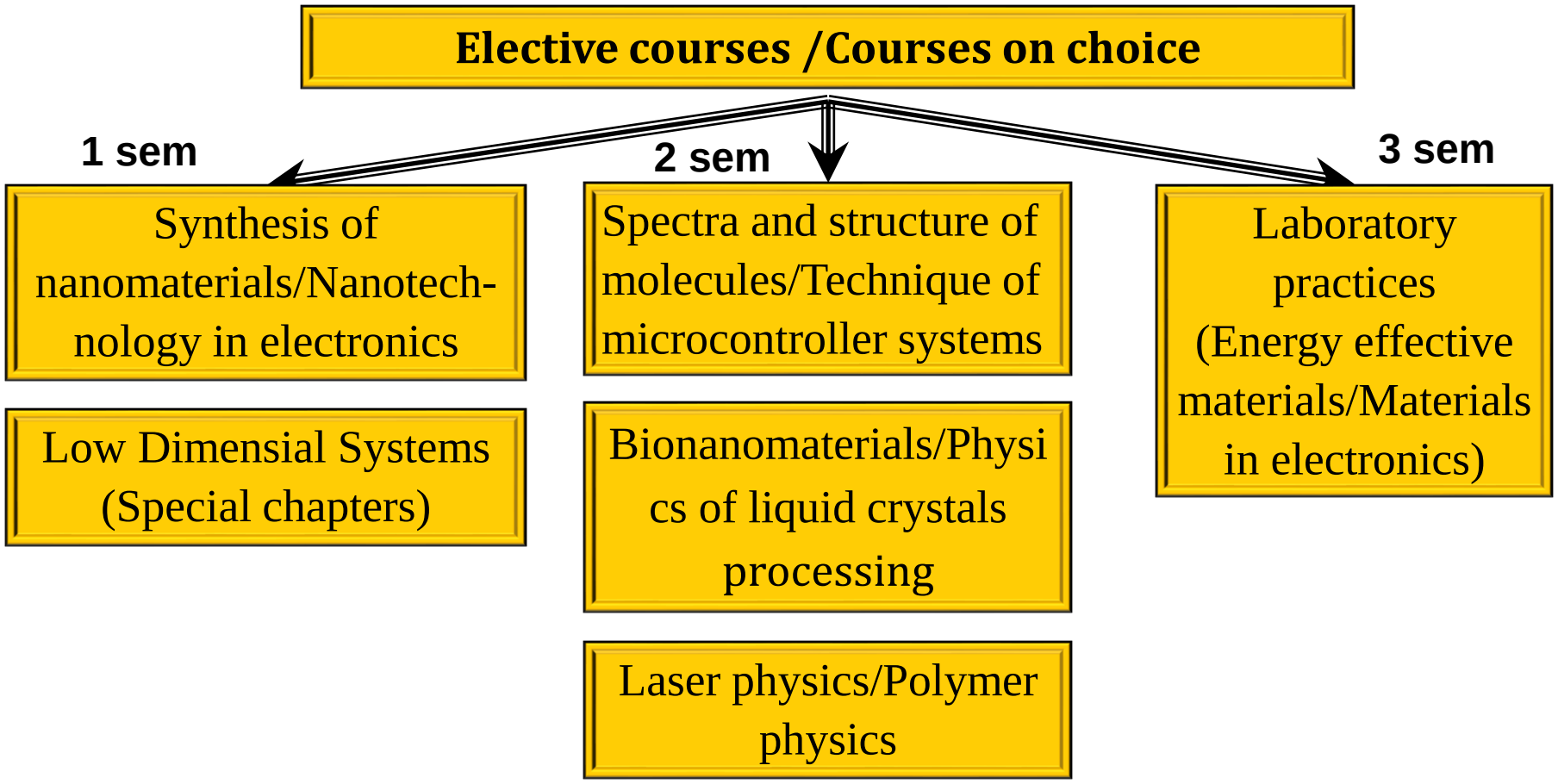


# Structure of curricula "Functional nanomaterials"

**University component**

| 1 sem | 2 sem | 3 sem |
|---|---|---|
| Modern concepts of the structure of matter | Problems of Applied Physics | Low dimensional systems |
| Additional chapters of quantum mechanics | Physics of wave processes | Optics of nanostructures |
| Condensed Matter Physics | Nonlinear physics | Theory of transfer |
| Group theory | Physics and chemistry of surface | |

# Structure of curricula "Functional nanomaterials"



# Structure of curricula “Photonics”

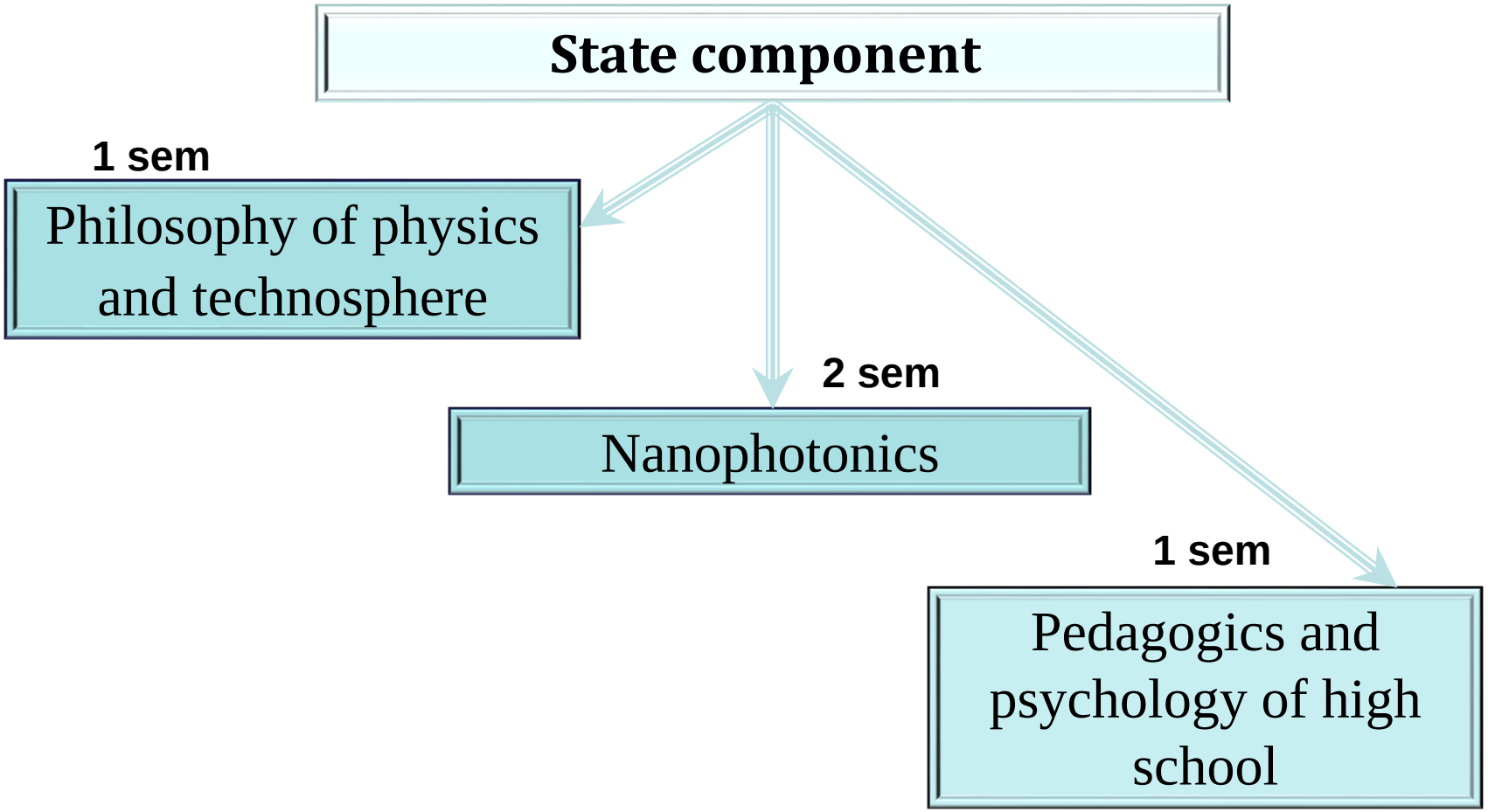
List of courses for the two-year master-level education on specialty 1-31 81 02 **PHOTONICS**

**State component**

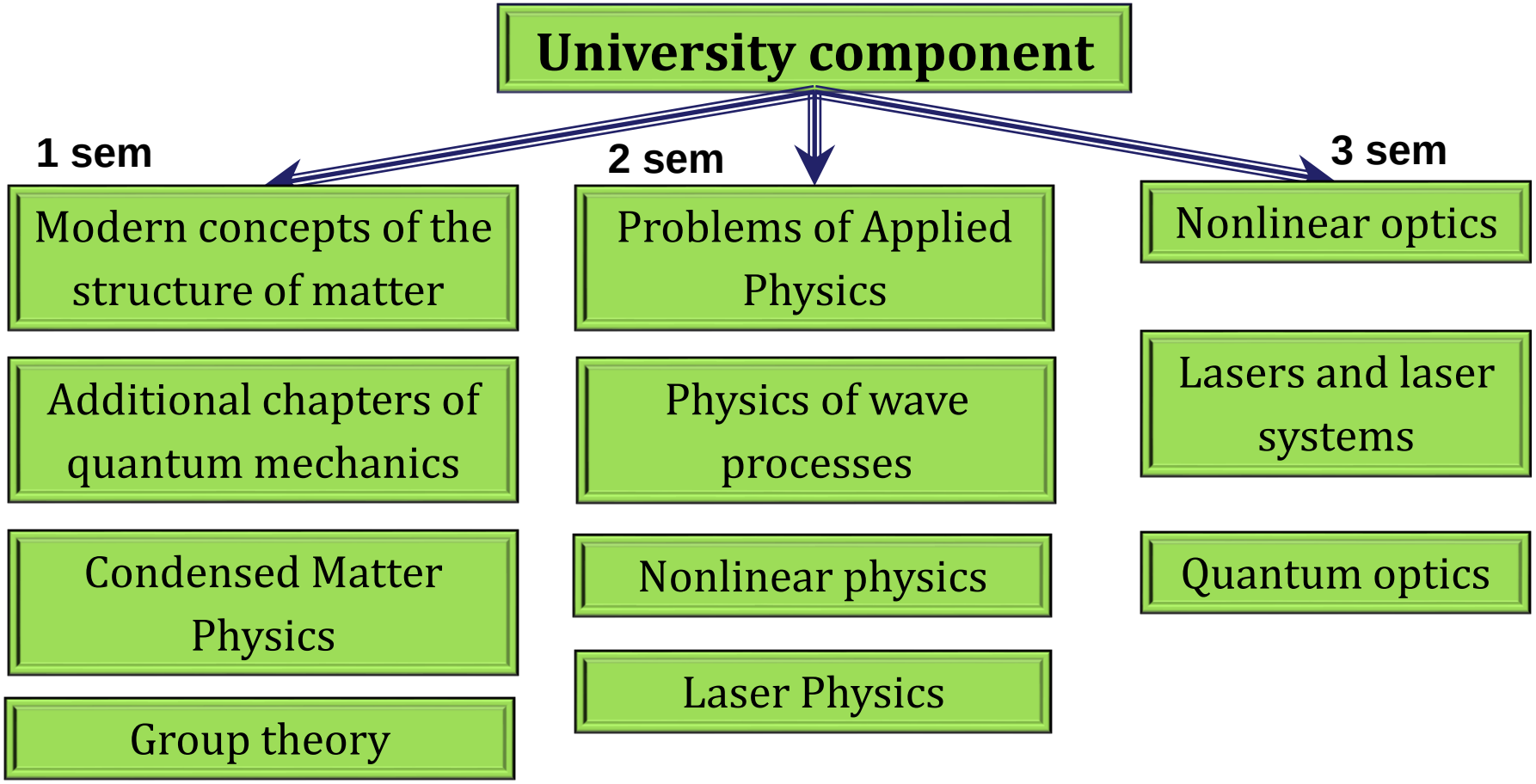
**University component**

**Elective courses/ Courses on choice**

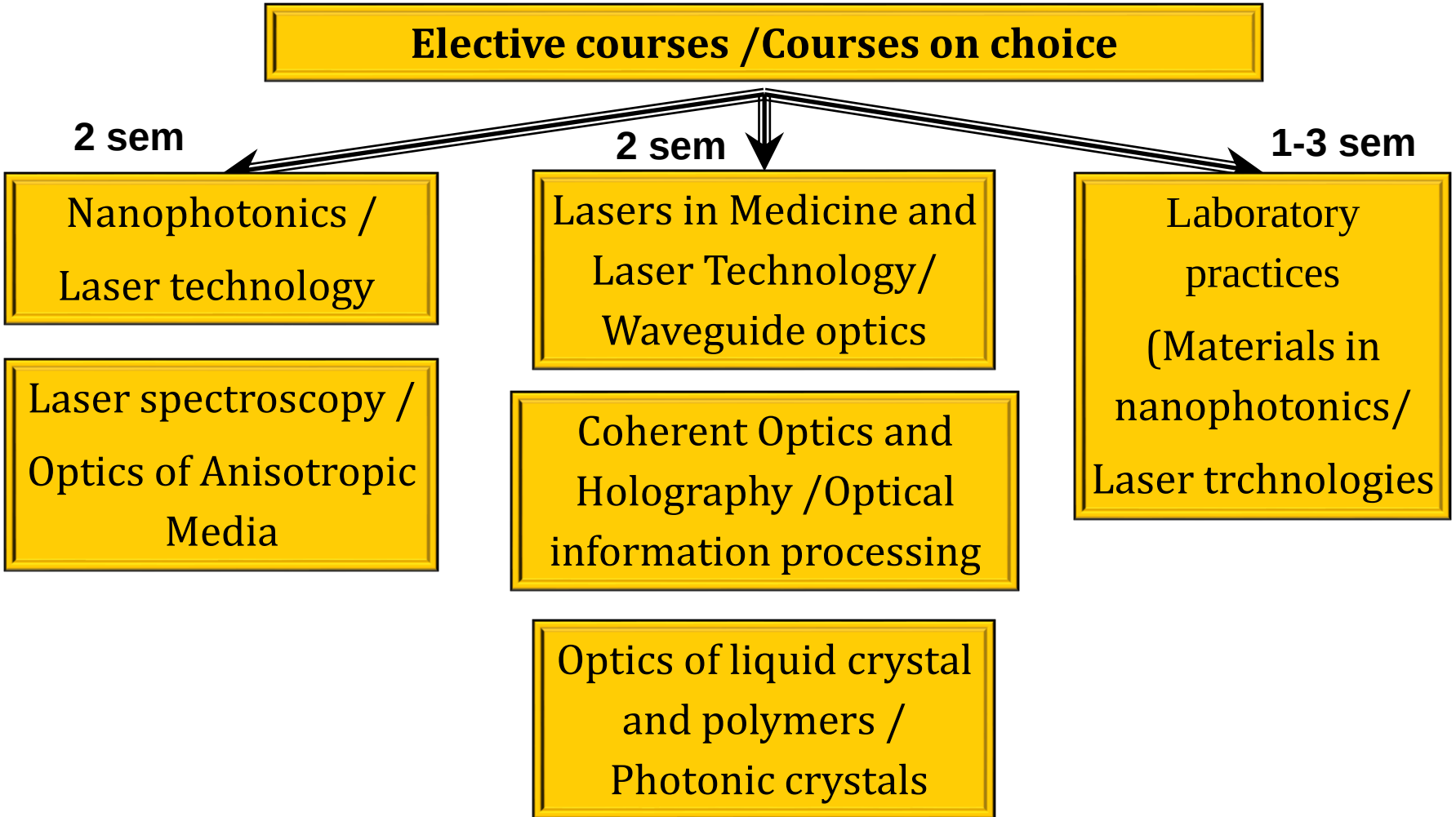
# Structure of curricula “Photonics”



# Structure of curricula "Photonics"



# Structure of curricula "Photonics"



# The current state of curricula preparation:

- we are waiting the approval of Educational Standards,

- after this approval, Universities validate curricula and programs of courses

# Progress of e-Book "Functional nanomaterials"

**Version: 23.10.2016**
**The course leader: Alexander FEDOTOV - BSU**

| Chapters/Papers | University | Contributors | Current state |
|---|---|---|---|
| Executive summary | BSU | A. Fedotov, V. Odzhaev | In progress |
| Introduction | BSU | A. Fedotov, V. Odzhaev | In progress |
| Chapter 1: Concepts of Low-Dimensional Effects | BSU | A. Fedotov | In progress |
| Chapter 2: Introduction to Physics of Surface/Interface | BSU | A. Fedotov | Abstract-rus, Abstract-eng, Part 1-rus http://dl.bsu.by/course/view.php?id=849 |
| Chapter 3: Thermal Properties of Nanomaterials | BSU | M. Tivanov | Abstract-rus http://dl.bsu.by/course/view.php?id=849 |
| Chapter 4: Chemistry of Nanomaterials | BSU | A. Mazanik | Abstract-rus, Abstract-eng http://dl.bsu.by/course/view.php?id=849 |
| Chapter 5: Physics of Carbon Low-dimensional Systems and Device Structures | BSU | N. Poklonski | Abstract-rus, Abstract-eng, Part 1-reng http://dl.bsu.by/course/view.php?id=849 |

# Progress of e-Book "Functional nanomaterials"

**Version: 23.10.2016**
**The course leader: Alexander FEDOTOV - BSU**

| Chapters/Papers | University | Contributors | Current state |
|---|---|---|---|
| Chapter 6: Arrays of carbon nanostructures: fabrication, properties and applications | BSU | V. Ksenevich | Abstract-rus, Abstract-eng http://dl.bsu.by/course/view.php?id=849 |
| Chapter 7: Conductive Polymers | BSU | V. Odzhaev (V.Odjaev) | Abstract-rus, Abstract-eng http://dl.bsu.by/course/view.php?id=849 |
| Chapter 8: Electrically conductive nano-composites | BSU | N. Gorbachuk, A. Fedotov | Abstract-rus, Abstract-eng http://dl.bsu.by/course/view.php?id=849 |
| Chapter 9: Magnetotransport and Magnetism in Nanocomposite and Multilayered Materials | BSU | J. Fedotova, J. Kasiuk | Abstract-rus, Abstract-eng, Part 1-rus http://dl.bsu.by/course/view.php?id=849 |
| Chapter 10: Nanoscale Materials and Structures for Spintronics | BSU | M.Lukashe-vich | Abstract-rus http://dl.bsu.by/course/view.php?id=849 |
| Chapter 11: Nanomaterials for Power Engineering | BSU | A. Mazanik | Abstract-rus, Abstract-eng http://dl.bsu.by/course/view.php?id=849 |
| Chapter 13: Fluorescent quantum dots for bioimaging | GrSU | N. Strekal | Abstract-rus, Abstract-eng, Part 1-reng http://dl.bsu.by/course/view.php?id=849 |

# Progress of e-Book "Functional nanomaterials"

**Version: 23.10.2016**
**The course leader: Alexander FEDOTOV - BSU**

| Chapters/Papers | University | Contributors | Current state |
|---|---|---|---|
| Chapter 14: Plasmonic nanomaterials for photonics, biochemistry and quantum technology | GrSU | N. Strekal | Abstract-rus, Abstract-eng http://dl.bsu.by/course/view.php?id=849 |
| Chapter 15: Nanofibers: synthesis, properties and applications | BSTU | N.R. Prokopchuk, Zh.S. Shashok | Paper-rus, Paper-eng http://dl.bsu.by/course/view.php?id=849 |
| Chapter 16: Elastomeric compositions with carbon nanomaterials | BSTU | K.V. Vishnevskii, Zh.S. Shashok | Papert-rus, Paper-eng http://dl.bsu.by/course/view.php?id=849 |
| Chapter 17: Paints and coatings, modified carbon nanomaterials | BSTU | N.R. Prokopchuk, A.L. Shutova | Paper-rus, Paper-eng http://dl.bsu.by/course/view.php?id=849 |
| Chapter 18: Plasma-chemical synthesis of nanocomposite polymer coatings | GSU | A.V. Rogachev, A.A. Rogachev, M. Yarmolenko | Abstract-rus, Abstract-eng http://dl.bsu.by/course/view.php?id=849 |
| Chapter 19: Carbon coatings doped with metals | GSU | A.V. Rogachev, D.Pilipcov, N. Fedosenko | Paper-rus, Paper-eng http://dl.bsu.by/course/view.php?id=849 |

# Progress of e-Book "Functional nanomaterials"

**Version: 23.10.2016**
**The course leader: Alexander FEDOTOV - BSU**

| Chapters/Papers | University | Contributors | Current state |
|---|---|---|---|
| Chapter 1: Sol-gel synthesis of functional materials | GSU | D. Kovalenko<br>V. Gaishun<br>A. Semchenko | Abstract-rus, Abstract-eng, Papert-rus<br>http://dl.bsu.by/course/view.php?id=849 |
| Chapter 21: Micro- and nanosensors | KU Leuven | Joan Peuteman | Papers-eng<br>http://dl.bsu.by/course/view.php?id=849 |
| References | BSU | | In progress |

# Progress of e-Book "Photonics"

**Version: 23.10.2016**
**The course leader: Alexey TOLSTIK - BSU**

| Chapters/Papers | University | Contributors | Current state |
|---|---|---|---|
| **Executive summary** | **BSU** | **A.Tolstik** | In progress |
| **Introduction** | **BSU** | **A.Tolstik** | In progress |
| **Chapter 1: Laser physics** | **BSU** | **A.Tolstik** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| 1.1. Principles of lasers operation and characteristics of laser radiation. Methods of the active medium pumping. Optical resonators. | **BSU** | **A.Tolstik** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| 1.2. Continuous mode of laser operation. Power generation. The lasing threshold. Free-running mode | **BSU** | **A.Tolstik** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| 1.3. Active and passive Q-switched modes. Power, energy and duration of the laser pulse. Methods of solid-state lasers resonators quality factor modulating. | **BSU, GSU** | **A.Tolstik, V. Myshkovets** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| 1.4. Generation of Mode-locked picosecond pulses | **BSU** | **A.Tolstik** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |

# Progress of e-Book “Photonics”

**Version: 23.10.2016**
**The course leader: Alexey TOLSTIK - BSU**

| Chapters/Papers | University | Contributors | Current state |
|---|---|---|---|
| 1.5. Methods of radiation frequency tuning | **BSU** | **I. Agishev** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| 1.6. The types of lasers and their applications | **BSU** | **D. Gorbach** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| 1.7. Industrial lasers. | **BSU, GSU** | **D. Gorbach, V. Myshkovets, A.Maksimenko** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| 1.8. Laser processing of materials | **BSU, GSU** | **D. Gorbach, V.Myshkovets, E.Baevich** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| **Chapter 2: Laser physics and nonlinear optics** | **BSU** | **A.Tolstik** | **In progress** |

# Progress of e-Book "Photonics"

**Version: 23.10.2016**
**The course leader: Alexey TOLSTIK - BSU**

| Chapters/Papers | University | Contributors | Current state |
|---|---|---|---|
| **Chapter 3: Coherent Optics and Holography** | **BSU** | **A. Melnikova** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| 3.1. Spatial and temporal coherence. | **BSU** | **A. Melnikova** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| 3.2. Types of holograms: thin and volume, amplitude and phase, reflective and transmissive. | **BSU** | **A. Melnikova** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| 3.3. Diffraction efficiency. | **BSU** | **A. Melnikova** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| 3.4. Spectral and angular selectivity. | **BSU** | **A. Melnikova** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| 3.5. Denisyuk holograms, Fourier hologram, rainbow hologram. | **BSU** | **A. Melnikova** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| 3.6. Dynamic holography. | **BSU** | **A.Tolstik** | **In progress** |
| 3.7. Holographic interferometry. | **GrSU** | **A. Ljalikov** | **In progress** |

# Progress of e-Book “Photonics”

**Version: 23.10.2016**
**The course leader: Alexey TOLSTIK - BSU**

| Chapters/Papers | University | Contributors | Current state |
|---|---|---|---|
| **Chapter 4: Optoelectronics** | | | In progress |
| 4.1. Physics of Condensed Matter | BSU | A. Fedotov | **Paragraph-rus** http://dl.bsu.by/course/view.php?id=850 |
| 4.2. Semiconductor optical detectors | KU Loven | J. Peuteman | **Paper-eng** http://dl.bsu.by/course/view.php?id=850 |
| 4.3. Solar cells | BSU | M. Tivanov | **Abstract-rus** http://dl.bsu.by/course/view.php?id=850 |
| 4.4. Applications of photovoltaic systems | KU Loven | J. Peuteman | **Paper-eng** http://dl.bsu.by/course/view.php?id=850 |

# Progress of e-Book “Photonics”

**Version: 23.10.2016**
**The course leader: Alexey TOLSTIK - BSU**

| Chapters/Papers | University | Contributors | Current state |
|---|---|---|---|
| **Chapter 5: Optical waveguides** | **BSU** | **D. Gorbach** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| 5.1. Optical waveguides | **BSU** | **D. Gorbach** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| 5.2. Waveguide modes | **BSU** | **D. Gorbach** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| 5.3. Input-output system | **BSU** | **D. Gorbach** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| 5.4. Fibre optical transmission system | **BSU** | **D. Gorbach** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |
| 5.5. Fibre sensors | **BSU** | **D. Gorbach** | **Abstract-eng** http://dl.bsu.by/course/view.php?id=850 |

# Progress of e-Book "Photonics"

**Version: 23.10.2016**
**The course leader: Alexey TOLSTIK - BSU**

| Chapters/Papers | University | Contributors | Current state |
|---|---|---|---|
| **Chapter 6: Nanophotonics** | **GrSU** | **N. Strekal** | **Paper-eng** http://dl.bsu.by/course/view.php?id=850 |
| 6.1. Quantun and classical confainment effect | **GrSU** | **N. Strekal** | **Paper-eng** http://dl.bsu.by/course/view.php?id=850 |
| 6.2. Density of states and modified density of states in system of low dimensionality | **GrSU** | **N. Strekal** | **Paper-eng** http://dl.bsu.by/course/view.php?id=850 |
| 6.3. Breaking through the difraction limit and near-field optics | **GrSU** | **N. Strekal** | **Paper-eng** http://dl.bsu.by/course/view.php?id=850 |
| 6.4. Quantum dots and basic ideas of nanophotnic devices | **GrSU** | **N. Strekal** | **In progress** |
| 6.5. Molecular electronics and photonics devices | **GrSU** | **G. Vasilyuk** | **Abstract-rus** http://dl.bsu.by/course/view.php?id=850 |
| 6.6 Metamaterials | **GSU** | **I. Semchenko** | **Paper-rus** http://dl.bsu.by/course/view.php?id=850 |

# Next steps

1. **Development of study programs by disciplines**

2. **Development of lectures and their presentations before the beginning of the testing procedure**

# 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.**

Erasmus+ 561525-EPP-1-2015-1-LV-EPPKA2-CBHE-JP-ERASMUS+CBHE

# СОВЕРШЕНСТВОВАНИЕ МАГИСТЕРСКОГО ОБРАЗОВАНИЯ В ОБЛАСТИ ФИЗИЧЕСКИХ НАУК В БЕЛОРУССКИХ УНИВЕРСИТЕТАХ

# IMPROVEMENT OF MASTER-LEVEL EDUCATION IN THE FIELD OF PHYSICAL SCIENCES IN BELORUSSIAN UNIVERSITIES"

BELARUSIAN STATE UNIVERSITY

PHYSICS

1862 RIGA TECHNICAL UNIVERSITY

**Цели:**

Модернизировать учебные планы в четырех университетах Беларуси в соответствии с Болонской практикой в физической науке в области электронных технологий;

Повысить качество и актуальность образования путем модернизации учебных программ, активного использования ИКТ, а также посредством сотрудничества для удовлетворения потребностей рынка труда.

**Objectives:**

Upgrade education plans in four universities of Belarus in accordance with the Bologna practice of physical science in the field of electronic technology;

Improve the quality and relevance of education through education programs modernization, the active use of ICT, as well as through cooperation in order to meet labor market needs.

**Главные задачи:**

Разработать современные учебные планы для магистрантов в области функциональных наноматериалов, фотоники и прикладной физики, учитывающие принципы Болонского процесса, и внедрить их в четырех белорусских университетах;

Разработать и модернизировать курсы и учебные материалы для двух учебных планов магистерского уровня по специальностям «Функциональные наноматериалы» и «Фотоника»;

Разработать среду обучения и преподавания на основе инновационных ИКТ.

**The main tasks:**

To develop modern educational plans for graduate/master students in the field of functional nanomaterials, photonics and applied physics, taking into account the principles of the Bologna process, and to implement them into four Belarusian universities;

Develop and upgrade courses and training materials for two master's level educational plans in the fields "Functional Nanomaterials" and "Photonics";

Develop teaching and learning environment based on innovative ICT;

KU LEUVEN

RIGA TECHNICAL UNIVERSITY

University of Cyprus

BELARUSIAN STATE UNIVERSITY

BELARUSIAN STATE TECHNOLOGICAL UNIVERSITY

YANKA KUPALA GRODNO STATE UNIVERSITY

FRANCISK SKORINA GOMEL STATE UNIVERSITY

MINISTRY OF EDUCATION OF THE REPUBLIC OF BELARUS

NanoPlatform

LOTIS TII

BELARUSIAN PHYSICAL SOCIETY

*info:* physics.bsu.by/ru/departments/energy physics/erasmus physics.rtu.lv

dl.bsu.by => Физический факультет => Проект Erasmus +

# Thank you for attention

Prof. A.K. Fedotov (BSU)

fedotov@bsu.by