APPROVED BY
Director of Institute of Non-Destructive Testing
_____ V.N. Borikov
«01» 09 2016

DISCIPLINE SYLLABUS
FOR 2016/2017 ACADEMIC YEAR

«BIOCOMPATIBLE MATERIALS»

Field (primary curriculum): 12.04.04 "Biotechnical systems and technologies"

Training profile: Biomedical Sciences and Engineering

Qualification (degree): Master

Basic academic enrollment plan 2016 *(year)*

Year: 1, semester: 1

Number of credits: 3

Types of academic activities	Time resource
Lectures	*16*
Seminars	*32*
Laboratory class	-
Classwork	*48*
Self-guided work	*60*
TOTAL, hours	*108*

Type of attestation: exam

Supporting subdivision: Department of Industrial and Medical Electronics, Institute of Non-Destructive Testing, TPU

Head of Department _____ Fedor A. Gubarev

Head of the field _____ Gennadiy S. Yevtushenko

Lecturer _____ Galina V. Arysheva

2016 г.

1. Place of course in the structure of the field

Course «Biocompatible Materials» refers to an optional interdisciplinary professional unit «Biomedical engineering » (B.M1).

Course «Biocompatible Materials» is preceded by the following disciplines (PREREQUISITES): no.

The contents of «Biocompatible Materials» course sections are consistent with the contents of the disciplines studied in parallel (COREQUISITES):

- Б.М1 «Mathematical Modeling of Biological Processes and Systems»,
- В.М2 «Topical Problems of Biomedical and Ecological Engineering»,
- В.М3 «Biomedical Instrumentation».

2. Course learning outcomes

In compliance with the primary curriculum requirements, mastering the course is focused on developing the following competences (learning outcomes) in students, including in accordance with the Federal State Educational Standards:

Table 1

Learning outcomes to be achieved by studying this course

Learning outcomes (competences from the Federal State Educational Standards)	Learning outcomes					
	Code	Knowledge	Code	Skills	Code	Experience
LO 1 (ОПК-2)	K.1.2 K.1.4	- the principles of the system concept, which is based on the analysis and synthesis of biotechnical systems; - channels of interaction of technical and biological elements.	S.1.4	- apply the principles of the system approach to the analysis and synthesis of biotechnical systems and technologies;	E.1.4 E.1.5	- use appropriate research methods of models and decision-making skills of the study models; - the methods of calculating the basic functional characteristics of biotechnical systems;
LO 2 (ОПК-1, ОПК-2)	K.2.1	- the main problems and directions of development of basic and applied research in the biomedical and environmental engineering;	S.2.1	- analyze the basic tendencies in the development of biomedical and environmental engineering, to identify perspective directions and its practical	E.2.2	- experience of methodological analysis of scientific research and its results.

	K.2.2 K.2.3	- characteristics of biological systems as elements of measuring and control engineering systems; - the realization of the promising areas of biomedical and environmental engineering;	S.2.2 S.2.3	applications; - apply the methods of the expert survey to determine trends in the development of innovative biomedical and environmental engineering; - formulate the tasks of realization of upcoming trend in biomedical and environmental engineering;		
LO 4 (ОПК-2, ОПК-4)	K.4.2	- classification and structure of biotechnical systems and different types of technologies;	S.4.3	- apply the principles of the system approach to the analysis and synthesis of biotechnical systems and technologies;	E.4.1	- methods of calculating the basic functional characteristics of biotechnical systems;
LO 5 (ПК-1, ПК-2)	K.5.1	- the main problems and directions of development of basic and applied researches in the biomedical and environmental engineering; subject areas using the achievements of biomedical and environmental engineering;	S.5.1	- analyze the state of scientific and technical problems by selection, study and analysis of literature and patent sources in the field of biotechnical systems and technologies;	E.5.2	- skills of methodological analysis of scientific research and its results;

During the course students will acquire general vocational and professional competences: ОПК-1, ОПК-2, ОПК-4, ПК-1, ПК-2.

3. Course structure and contents

The course outline:

Lecture 1. **Section 1.** General properties of materials and their compatibility with biological environments.

1.1 Mechanical, chemical, electrical and magnetic properties of materials.

Resistance of materials to various influences.
1.2 Requirements to materials for medical and biological applications. Biocompatibility.
Seminar 1: Solving tasks on the calculation of the mechanical, chemical, electrical and magnetic parameters.
Seminar 2: «Heat and humidity properties, solubility, light stability and biocompatibility of medical materials».

Lecture 2. **Section 2.** Metal materials and their alloys in biomedical practice.
2.1 Classification and properties of metals and alloys. Structure and crystallization of metals.
2.2 The main types of alloys. Diagrams of two-component alloys.
Seminar 3: Calculation and construction of phase diagrams of binary alloys.
Seminar 4: «Properties, classification and marking of medical steel».

Lecture 3.
2.3 Electrical and thermal conductivity of metals and alloys.
2.4 Single-metals.
2.5 Alloys and steel.
Seminar 5: Solving tasks on the calculation of the electrical conductivity and thermal conductivity of conductive materials.
Seminar 6: «The use of solid conductive materials in biomedical practice».

Lecture 4. **Section 3.** Semiconductor materials in biomedical practice.
3.1 General properties and classification of semiconductors.
3.2 Optical and photoelectric phenomena in semiconductors.
3.3 Thermoelectric phenomena.
Seminar 7: Solving tasks on the calculation of intrinsic and extrinsic conductivity, concentration and mobility of charge carriers, conductivity and photoconductivity of semiconductor materials.
Seminar 8: «Thermoelectric phenomena in semiconductors: effect of Seebeck, Peltier, Thomson, Hall».

Lecture 5. **Section 4.** The use of dielectric materials in the biomedical practice.
4.1 Classification of dielectrics.
4.2 The electrical conductivity, polarization, dielectric loss and electrical breakdown of dielectrics.
4.3 Dielectric materials for various purposes.
Seminar 9: Solving problems on the calculation of the electrical conductivity and dielectric polarization, dielectric losses.
Seminar 10: Test №1.

Lecture 6. **Section 5.** The properties of living tissues.
5.1 Features of living organism as an object of research. Mechanical properties of biological tissues and fluids.
5.2 Classification of composite physical and chemical environments (living organisms) on the nature of the electrical conductivity.
Seminar 11: Calculating the tasks for the current density in a complex environ consisting of conductors and dielectrics (human or animal).

Seminar 12: «The most frequently used environ composition in medicine».

Lecture 7.

5.3 Features of conductive, dielectric, magnetic, optical and acoustic properties of living tissue (biological objects).

5.4 The stability properties of the functional materials. Sterilization treatment.

Seminar 13: Solving problems on the calculation of surface roughness and adhesion of tissue cells on the surface of medical materials.

Seminar 14: «Cell reactions to foreign body, toxicity, hemocompatibility».

Lecture 8. **Section 6.** Materials for interstitial prosthetics.

6.1 Basic requirements for materials.

6.2 Membranes for controlling the composition of biological fluids.

6.3 Blood liquids.

6.4 Implants (including biodegradation).

Seminar 15: «Implants in ophthalmology and orthopedics, implants of blood vessels and soft tissues».

Seminar 16: Test №2.

As the consequence of mastering course «Biotechnical systems and technologies », students must achieve the following results:

Table 2

Planned course learning outcomes

№ п/п	Result
CLO 1 (РД1)	Know the fundamental principles of interaction between a living organism with different medical supplies.
CLO 2 (РД2)	Have an idea about modern methods of obtaining and analyzing the properties of biocompatible materials and medical devices.
CLO 3 (РД3)	Able to apply the results and planning methods to solve practical problems in various fields of biomedical research.

4. Educational technology

In studying the discipline "Biocompatible Materials" the following educational technology applied:

Table 3

The methods and forms of organization of education

FOE The methods	Lecture	Seminar	Tr.*, MC**	Iws***	T. pr.****
IT- methods					
Teamwork		+			
Case-study					

Game					
Methods of problem-based learning	+	+			
Training based on experience	+	+			
Advancing independent work	+	+		+	
Project method					
Searching method		+		+	
Research method	+				
Other methods					

* – Training, ** – Master Class, ***– Individual work of students , **** - Team project

5. Organization and training materials for students' self-guided work

5.1. Types and forms of self-guided work

Students' self-guided work includes everyday and creative problem-oriented self-guided work (SGW).

Everyday self-guided work is focused on extending and reinforcing students' knowledge, developing practical skills and includes:

- working with lecture materials, looking for and overviewing literature and electronic sources of information in compliance with an individually predetermined course problem;
- advanced self-guided work;
- performing home tasks, home tests;
- studying topics meant for self-guided studying;
- getting prepared for laboratory work, practical exercises and seminars;
- getting prepared for control work and exam.

Creative self-guided work includes:

- searching, analyzing, structuring and presenting information;
- analyzing academic publications under topics predetermined by the professor.

5.2. The content of individual work on discipline

Topics to be discussed at a separate development:

- Analytical review of the scientific literature on the current state of affairs (last 5 years) in medical material science (e.g. TiNi alloys, stainless steel, etc.).

5.3. Control of individual work

Evaluation of results of individual work is done on the issues included in the current and interim control and execution of individual tasks. When the individual work is recommended to use materials posted on the personal website of the teacher: http://portal.tpu.ru:7777/SHARED/a/ARYSHEVA.

6. Means of current and interim assessment of course learning outcomes

Course learning outcomes are to be assessed by means of the following control procedures:

Table 4

Control procedures	Course learning outcomes
Doing practical (classroom) tasks	CLO 1 (РД 1) CLO 2 (РД 2) CLO 3 (РД 3)
Preparing and protection of the essay and/or individual task	CLO 1 (РД 1) CLO 2 (РД 2) CLO 3 (РД 3)
Doing control tasks	CLO 1 (РД 1) CLO 2 (РД 2) CLO 3 (РД 3)
Exam	CLO 1 (РД 1) CLO 2 (РД 2) CLO 3 (РД 3)

The following tools (assessment tools fund) are meant for assessing the course learning outcomes as part of control procedures:

- incoming control questions;
- control questions to be asked during practical exercises;
- self-control questions;
- testing questions;
- questions to be asked during exam.

7. Course learning outcomes rating

The evaluation of the course mastering quality during the current and midterm assessment of students is carried out in accordance with the "Regulation on carrying out current assessment and midterm assessment in TPU", approved by the current version of the Rector’s order.

In accordance with the Course Progress Chart:

- current attestation (assessing the quality of mastering theoretical materials (answers to questions, etc.) and practical activity results (solving tasks, performing exercises, solving problems, etc.) is to be performed during the semester (assessed in points (no more than 60 points), by the end of the semester students must collect at least 33 points);
- interim attestation (examination, credit test) is to be performed at the end of the semester (assessed in points (no more than 40 points), students must collect at least 22 points at an exam (credit test)).

The final rating is determined by adding together the credits collected during

current and interim attestation procedures. The highest final rating equals 100 points.

8. Courseware

Primary literature:

1. Porous silicon for biomedical applications [Electronic resource] / ed. H. A. Santos. - 1 компьютерный файл (pdf; 32 Mb). – Amsterdam: Elsevier, 2014. Схема доступа: http://www.lib.tpu.ru/fulltext2/m/2016/science_book/Porous%20Silicon%20for%20Biomedical%20Applications_2014.pdf
2. Precious Metals for Biomedical Applications [Electronic resource] / eds. N. Baltzer, T. Copponnex. - 1 компьютерный файл (pdf; 30 Mb). - Amsterdam: Elsevier, 2014. - Схема доступа: http://www.lib.tpu.ru/fulltext2/m/2016/science_book/Precious%20Metals%20for%20Biomedical%20Applications_2014.pdf
3. Semiconducting Silicon Nanowires for Biomedical Applications [Electronic resource] / ed. J. L. Coffer. - 1 компьютерный файл (pdf; 57 Mb). — Amsterdam: Elsevier, 2014. – Схема доступа: http://www.lib.tpu.ru/fulltext2/m/2016/science_book/Semiconducting%20Silicon%20Nanowires%20for%20Biomedical%20Applications_2014.pdf

Supplementary literature:

1. Ivanova, Elena. New functional biomaterials for medicine and healthcare [Electronic resource] / E. P. Ivanova, K. Bazaka, R. J. Crawford. — 1 компьютерный файл (pdf; 15 Mb). — Oxford: Woodhead Publishing Limited, 2014. — Заглавие с титульного экрана. — Доступ из корпоративной сети ТПУ. — Системные требования: Adobe Reader. Схема доступа: http://www.lib.tpu.ru/fulltext2/m/2016/science_book/New%20Functional.pdf
2. Responsive Membranes and Materials / editors D. Bhattacharyya [and oth.]. — Chichester: Wiley, 2013. — 405 p.: il.
3. Liu, Jian-Qin. Biomolecular Computation for Bionanotechnology / J.-Q. Liu, K. Shimohara. — Boston: Artech House, 2007. — 286 p.: il

Internet resources:

- eLIBRARY.RU [Электронный ресурс]: scientific electronic library. – URL: http://www.elibrary.ru
- Руконт [Электронный ресурс]: interbranch electronic library. – URL: http://rucont.ru

Software: specialized software is not required.

9. Facilities required for the course

Table 5

№ п/п	Name (computer classrooms, university laboratories, equipment)	Building, rooms, number of installations
1.	Lecture room	Building 16V, room 318
2.	Lecture room	Building 16V, room 326

The syllabus is developed in compliance with the Primary Curriculum Standard of TPU in accordance with the requirements of the Federal State Educational Standard for the training field 12.04.04 «Biotechnical systems and technologies» and profile «Biomedical engineering».

The syllabus is approved at the meeting of the Department of Industrial and Medical Electronics, Institute of Non-Destructive Testing: protocol № 10.16 as of 26/08/2016.

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