National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Department
biomedical engineering

SYSTEMIC PHYSIOLOGY

Working program of educational discipline (Syllabus)

Requisites of the Course	
Cycle of Higher Education	***Second (master's)***
Branch of knowledge	*16 Chemical and Bioengineering*
Specialty	*163 Biomedical Engineering*
Educational program	*Medical Engineering*
Course status	*Selective*
Mode of study	*full-time / day / mixed / remote*
Year of study/Semester	*1st year (spring semester)*
ECTS workload	*5 ECTS credits / 150 hours*
Testing and Assessment	*Exam, Module Test, Home Control Work*
Course schedule	*According to the schedule on the site http://rozklad.kpi.ua/*
Language of instruction	*English*
Information about course supervisor / teachers	***Lecturer:*** *Candidate of Biological Sciences, Associate Professor of BME Svitlana Vovianko, e-mail: sivovianko@gmail.com, Telegram - https://t.me/vovianko_svitlana* ***Practical:*** *Candidate of Biological Sciences, Associate Professor of BME Svitlana Vovianko, e-mail: sivovianko@gmail.com, Telegram - https://t.me/vovianko_svitlana*
Course placement	*Platform «Sikorsky» - course «Systemic Physiology»*

Distribution of hours				
Semester	**Lectures**	**Practical**	**Laboratory**	**Self-study**
Autumn/fall semester	*28*	*26*	*18*	*78*

Outline of the Course

1. Course description, goals, objectives, and learning outcomes

The main purpose of the Course "Systemic physiology" is to form students' ability to analyze the systemic patterns of functioning of the whole organism in its inseparable connection with the environment, to assess biological and technical aspects and consequences of interaction of engineering and bioengineering objects with biological systems, and to predict their mutual influence.

Understanding the system is equivalent to creating its model. The application of an analytical approach is necessary for modeling and creating modern biotechnical systems. The course "Systemic Physiology" aims to analyze the systemic patterns of functioning of the whole organism in its inseparable connection with the environment on the basis of knowledge of life and functioning of individual organs. The solution of this problem is based on the Pyotr Anokhin theory of functional systems as dynamic self-organized and self-regulating organizations, whose activities are aimed at providing useful for life adaptive results.

The Course integrates labs and problem sets to provide opportunities for practice and includes clinical applications relevant to the biomedical engineering student.

Skills are required to study the Course:

- *Knowledge of the basics of anatomy and physiology, knowledge of Microsoft Office; programming skills; skills in image analysis.*

***General competencies** (OPP was put into effect by the Rector's Order NON/ 89/2021 of 19.04.2021):*

***GC 1** - Ability to abstract thinking, analysis and synthesis.*
***GC 2** - Ability to search, process and analyze information from various sources.*
***GC 3** – Ability to identify, formulate and solve problems.*
***GC 4** – Ability to work in a team.*

***Special (professional) competencies** (OPP was put into effect by the Rector's Order NON/ 89/2021 of 19.04.2021):*

***PC 1** – Ability to solve complex problems of biomedical engineering using the methods of mathematics, natural and engineering sciences.*
***PC 6** – Ability to study biological and technical aspects of functioning and interaction of artificial biological and biotechnical systems.*
***PC 8** – Ability to develop models and perform experiments aimed at solving problems related to human health, according to the specific needs of scientific research, to analyze, explain the results and evaluate the cost of research.*
***PC 9** – Ability to create tools and methodologies of scientific activity, evaluation and implementation of the results of modern developments, solutions and achievements of engineering and exact sciences in medicine and biology.*
***PC 12** – Ability to perform research and observations on the interaction of biological, natural and artificial systems (prostheses, artificial organs, etc.), to plan biotechnical tests of artificial prostheses and systems.*

***The program learning outcomes after studying the discipline "Medical Microprocessor Systems" are** (OPP was put into effect by the Rector's Order NON/ 89/2021 of 19.04.2021):*

***PLO 1** – Understanding of fundamental-applied, medical-physical and bioengineering bases of technologies and equipment for research of physiological and pathological processes of the person.*
***PLO 18** – Creation and improvement of means, methods and technologies of biomedical engineering for comprehensive research and development of bioengineering objects and systems of medical and technical purpose.*
***PLO 20** – Evaluation of biological and technical aspects and consequences of interaction of engineering and bioengineering objects with biological systems, anticipation of their mutual influence, legal, deontological and moral and ethical consequences of use.*
***PLO 22** – Presentation of research and development results in the state and foreign languages in the form of applications for inventions, scientific publications, reports at scientific and technical events.*

2. Prerequisites and postrequisites of the course (place in the structural and logical scheme of education according to the relevant educational program)

The course "Systemic Physiology" has an interdisciplinary nature. According to the structural and logical scheme of preparation of master's degree program the course "Systemic Physiology" is closely related to the following courses: "High-tech systems for diagnostics and therapy", "Biomedical information display systems".
The acquired practical skills and acquired theoretical knowledge of the course "System Physiology" can

be used for research practice of the master and in further practical work in the specialty.

3. Course Overview

The main parts and subjects that will be considered in the process of studying the course:

Unit1. General characteristics of the system approach in physiology

Subject1.1. System Approach in Physiology. General Principles of functioning of the Organism as a System.
Subject1.2. Cellular and Subcellular Structures. Elementary Physiological Processes.
Subject1.3. Neurohumoral Regulation of Physiological Functions

Unit2. Basics of Life.

Subject2.1. Metabolism and Energy balance.
Subject2.2. Temperature Control.
Subject2.3. Body Fluid Compartments.
Subject2.4. Barrier Functions.

Unit3. Systemic Mechanisms of Homeostasis

Subject3.1. Cardiovascular System.
Subject3.2. Respiration.
Subject3.3. Digestion.
Subject3.4. Excretion.
Subject3.5. Acid-base balance.

Unit4. Systemic Mechanisms of Behavior.

Subject4.1. System Architecture of Behavioral Acts.
Subject4.2. Sensory Systems.
Subject4.3. Actuators of Functional Systems.
Subject4.4. Systemogenesis.

Unit5. Functional Systems Complexity Research Methods.

Subject5.1. Fractal Analysis.
Subject5.2. Estimation of Algorithmic Complexity by Lempel-Ziv Compression.
Subject5.3. Entropy Analysis.

4. Coursebooks and teaching resources

Basic:

1. *Anokhin P.K., Biology and Neurophysiology of the Conditioned Reflex and Its Role in Adaptive Behavior. – Pergamon, Oxford, 1974.*
2. *EZ Entropy: a software application for the entropy analysis of physiological time-series // BioMedical Engineering OnLine/ 2019, volume 18, Article number: 30 // Access: https://biomedical-engineering-online.biomedcentral.com/articles/10.1186/s12938-019-0650-5*
3. *Hall J.E., Hall M.E. Guyton and Hall Textbook of Medical Physiology. 14th Edition. — Elsevier, 2020. — 1028 p.*
4. *Lempel-Ziv Compression // Access: https://web.stanford.edu/class/ee376a/files/EE376C_lecture_LZ.pdf*
5. *Red'ko V.G., Prokhorov D.V., Burtsev M.B. Theory of Functional Systems, Adaptive Critics and Neural Networks // Proceedings of International Joint Conference on Neural Networks, Budapest, 2004, pp.1787-1792 // Access: https://www.keldysh.ru/pages/mrbur-web/publ/IJCNN04.pdf*
6. *Silverthorn, Dee Unglaub. Human Physiology: An Integrated Approach, 5th edition, Pearson/Benjamin Cummins, 2010.*
7. *Sherwood, Lauralee. Human Physiology: From Cells to Systems, 9th edition, Brooks/Cole, Cengage Learning, 2016. - 912 p.*

8. *Sudakov K.V. The theory of functional systems: general postulates and principles of dynamic organization (dedicated to the Anokhin Centenary) // Integr Physiol Behav Sci. – 1997. – 32 (4). – P.392-414.*
9. *Анохин П.К. Принципиальные вопросы общей теории функциональных систем. М: Директ-Медиа, 2008.*
10. *Гайтон А.К. Медицинская физиология / А.К.Гайтон, Дж.Э. Холл / Пер. с англ.; Под ред. В.И.Кобрина. – М.: Логосфера, 2008. – 1296 с.*
11. *Судаков К.В. Физиология. Основы и функциональные системы. Курс лекций. — М.: Медицина, 2000. — 772 с.*

Supplementary:

1. *Анохин П.К. Очерки по физиологии функциональных систем. – М.: Медицина, 1975. – 225 с. С. 17-59.*
2. *Анохин П.К. Избранные труды. Философские аспекты теории функциональной системы. М.: Наука, 1978. — 395 с. // http://elib.gnpbu.ru/text/anohin_sistemnye-mehanizmy_1979/go,2;fs,1/*
3. *Анохин П.К. Избранные труды. Системные механизмы высшей нервной деятельности.- М.: Наука, 1979. – 458 с.*
4. *Анохин П. К. Узловые вопросы теории функциональной системы: монография - Москва: Наука, 1980.*
5. *Блюмнфельд Л.А. Інформація, термодинаміка і конструкція біосистем // http://www.pereplet.ru/obrazovanie/stsoros/136.html*
6. *Опритов В.А. Энтропия биосистем // Соросовский образовательный журнал. – 1999. – №6. – С.33 – 38.*
7. *Судаков К.В. Общие закономерности динамической организации функциональных систем. Статья. Опубликована в Курском научно-практическом вестнике "Человек и его здоровье" — 2005. — №2. — С. 4-13.*
8. *Судаков К. В. Общая теория функциональных систем. - М.: Медицина,1984. - 224 с.*
9. *Судаков К. В. Функциональные системы организма. - М: Медицина, 1987.- 432 с.*
10. *Судаков К. В. Избранные лекции по нормальной физиологии. - М.: Эрус, 1992.- 243 с.*
11. *Судаков К. В. Теория функциональных систем. Под ред. Нувахова Б.Ш. - М.,1996.- 89 с.*

Educational content

5. Methods of mastering the discipline (educational component)

№ s/n	Subject	Program learning outcomes	The main tasks	
			Control measure	Deadline
1.	General characteristics of the system approach in physiology	PLO 1 PLO 20	Practical work 1, 2	3rd week
2.	Basics of Life	PLO 1 PLO 20	Practical work 3, 4	4th week
3.	Systemic Mechanisms of Homeostasis. Cardiovascular System	PLO 1 PLO 20	Practical work 5, 6 Laboratory work 1, 2	5th week
4.	Systemic Mechanisms of Homeostasis. Respiration	PLO 1 PLO 20	Practical work 7 Laboratory work 3	6th week
5.	Systemic Mechanisms of Homeostasis. Digestion. Excretion. Acid-base balance	PLO 1 PLO 20	Practical work 8 Laboratory work 4	7th week
6.	System Architecture of Behavioural Acts	PLO 1 PLO 20	Practical work 9 Laboratory work 5	9h week
7.	Effectors and Actuators of Functional Systems	PLO 1 PLO 20	Practical work 10 Laboratory work 6	10th week

8.	*Systemogenesis*	*PLO 1* *PLO 20*	*Practical work 11*	*11th week*
9.	*Functional Systems Complexity Research Methods*	*PLO 1* *PLO 18* *PLO 20*	*Practical work 12* *Laboratory work 7, 8, 9*	*12th – 13th week*
10.	*Module Test*	*PLO 1* *PLO 18* *PLO 20*	*Module Test writing*	*14h week*
11.	*Home Control Work*	*PLO 1* *PLO 18* *PLO 20* *PLO 22*	*Registration and submission of the work*	*13th – 14th week*

6. Self-study

Preparing for the classes is carried out in accordance with the plan of the course with the links to the MOODLE platform.

One of the main types of semester control during the mastering of the discipline "Systemic Physiology" is the Home Control Work. Home Control Work is performed in accordance with the requirements, within the period specified by the teacher.

The main purpose of the Home Control Work is to solve a practical problem using the material learned in lectures and independently, and practical skills acquired in practical work.

Approximate subject of a Home Control Work:

1. *Self-regulation as a key principle of a functional systems dynamic self-organizing*
2. *The principle of cooperative interaction in the blood circulation system*
3. *Reflex and functional systems as a unit of life.*
4. *Hierarchy of functional systems.*
5. *The role of correlative relationships in the functioning of the excretion system*
6. *Architectonics of a Temperature Control functional system*

The title page of the Home Control Work should have the following content: the name of the university; name of the faculty; name of department; name of specialty, name of educational-professional program, name of academic course; option of Home Control Work; surname and name of the student, year of study, code of the academic group, year.

The title page is followed by a detailed plan (content) of the calculation and graphic work, which should highlight the introduction, sections of the main content (main topics studied), their subdivisions (if necessary), conclusion, list of sources used. The table of contents on the right indicates the page numbers at the beginning of each question. Each section begins on a new page.

The total amount of a Home Control Work, depending on the chosen subject can vary from 25 to 40 pages of the main text (in consultation with the teacher). The amount of a Home Control Work is determined by the student's ability to explain results briefly and comprehensively at the same time.

Mandatory requirement: clear reference to the sources of information. All figures, facts, opinions of scientists, quotations, formulas should be referenced as [2, p. 54] (the first digit is the number of the source in the list of references given at the end of the Home Control Work, and the second digit is the page number in the source referenced). It is desirable to use tables, diagrams, graphs, charts, etc. The list of references (not less than 10 sources) is made out according to operating rules. If the information is taken from the Internet, you need, as for ordinary literature, specify the author, the title of the article, and then provide the address of the site on the Internet.

Home Control Work is evaluated by the following criteria: logic of the plan; completeness and

depth of a subject disclosure; reliability of the received data; presentation of practical materials and results of calculations; correctness of formulation of conclusions of the received results and conclusions; design; substantiation of the student's own opinion on this issue in the form of a conclusion.

Deadline for Home Control Work submission for examination: 13th – 14th week of study.

Home Control Work must meet the requirements of academic integrity. In case of academic dishonesty, the work is canceled and not checked.

Policy and control

7. Attendance policy

Attending classes

Attendance at lectures is optional. Performance and defense of a laboratory works is mandatory. Attending practical classes is desirable. All works and activities are aimed at the students' compliance with the assessment rating requirements. A significant part of a student rating is formed through active participation in activities in practical classes. Therefore, skipping a practical class does not allow a student to get points in the semester rating.

General assessment takes place according to a scheme of the agreed grading system. Expected learning outcomes, control measures and deadlines are announced to students in the first practical class.

Control measures missed

Missed labs can be worked out during the next labs, (provided that the task is scheduled for the current classes), or in consultations.

Skipped Module Test or express tests cannot be completed.

Skipped Module Test can be worked out in consultations.

Home Control Work which is submitted for inspection in violation of the deadline is evaluated with a decrease in the number of weight points.

Violation of deadlines, penalty points and rewarding points

Rewarding points		Penalty points*	
Criterion	Weight points	Criterion	Weight points
Practical or laboratory work improvement	1 point (for each work)	Untimely implementation of a practical work	From -0.5 points to -3 points (depending on the delivery date)
Online courses completed on the topics that are agreed with the teacher	5 points	Untimely implementation of a laboratory work	From -0.5 points to -3 points (depending on the delivery date)
Registration of scientific work for participation in the competition of student scientific works	10 points	Untimely implementation of a Module Test	From -0.5 points to -5 points (depending on the delivery date)
Writing of abstracts, articles, participation in international, national and / or other events or competitions on the subject of the Course	From 5 points to +10 points	Untimely implementation of a Home Control Work	From -2 points to -5 points (depending on the delivery date)

** if the control measure was missed for a good reason (illness, which is confirmed by a certificate of the established sample) - penalty points are not accrued.*

Academic integrity

The policy and principles of academic integrity are defined in Section 3 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: https://kpi.ua/code.

Norms of ethical behavior

Normative principles of behavior of students and employees, defined in sections 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: https://kpi.ua/code.

Procedure for appealing the results of control measures

Students have the opportunity to raise any issue related to the control procedure and expect it to be addressed according to predefined procedures.

The student has the right to appeal the results of the control measure according to the approved provision on appeals in the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (approved by the order №NON/128/2021 from 20.05.2021) - https://osvita.kpi.ua/index.php/node/182

Inclusive education

The course "Systemic Physiology" can be taught to the most of students with special educational needs.

Distance learning

Distance learning takes place through the Sikorsky Distance learning Platform «Sikorsky».

Distance learning through additional online courses on certain topics is allowed subject to agreement with students. If a small number of students wish to take an online course on a specific topic, studying the material with such courses is allowed, but students must complete all the tasks provided in the discipline.

The list of courses is offered by the teacher after the students have expressed a desire (because the bank of available courses is updated almost every month).

The student provides a document confirming the completion of the distance course (in the case of a full course) or provides practical tasks from the distance course and subject to an oral interview with the teacher on the topics can receive grades for control measures provided for the studied topics (express control / test tasks, practical work).

Performance of practical works, and also performance and defense of a Home Control Work is carried out during self-study work of students in a remote mode (with a possibility of consultation with the teacher through e-mail, social networks).

Teaching in a foreign language

Teaching in English is carried out only for foreign students.

At the request of students, it is allowed to study the material with the help of English-language online courses on topics that correspond to the topics of specific classes.

8. Monitoring and grading policy

Grading system (current control):

№ s/n	Control measure	%	Weight points	Number	Total
1.	Express tests	21	1,5	14	21
2.	Performance and defense of a laboratory works	21	3	7	21
3.	Module Test (MT)	18	18	1	18
4.	Home Control Work (HCW)	10	10	1	10
5.	Exam[1]	30	30	1	30
	Total				100

[1] – The exam is carried out orally

Calendar control *(CC) is performed twice a semester as monitoring of the current state of compliance with syllabus requirements.*

The purpose of calendar control is to improve the quality of student learning and monitor the implementation of the schedule of the educational process by students.

Criterion			The first CC	The second CC
Deadline of calendar controls			8th week	14th week
Requirements to obtain a positive calendar control	Current grade		≥ 24 points	≥ 30 points
	Execution of laboratory works	LW No.1	+	+
		LW No.3-6	-	+
	Express control works	At least 4 of any lectures	+	-
		At least 8 of any lectures	-	+
	Module Test	Estimated MT	-	+
	Home Control Work	Estimated HCW	-	-

In the case of a plagiarism or an academic poor quality during training the control measure is not credited.

Semester certification of students

Mandatory requirements for the admission to the Exam		Criterion
1	Current grade	RD ≥ 30
2	All laboratory works are completed	More than 0 points
3	Home Control Work is completed	More than 6 points

The results are announced to each student separately in the presence or remotely (by e-mail). It is also recorded in the "Electronic Campus" system.

Optional requirements for the admission to the Exam:

1. *Active work during practical classes.*
2. *Positive result of the first and the second calendar control.*
3. *Attending of lectures.*

The final performance score or the results of the Final Test are adopted by university grading system as follows:

Number points	Assessment on the university scale
100-95	Excellent / Відмінно
94-85	Very good / Дуже добре
84-75	Good / Добре
74-65	Satisfactory / Задовільно
64-60	Satisfactory / Достатньо
Less 60	Unsatisfactory / Незадовільно
The course requirements are not met	Not allowed / Не допущено

9. Additional information on the course (educational component)

The list of questions for preparation for Module Test, and also for preparation for the Exam is given in appendix 1.

Distance learning through additional online courses on certain topics is allowed subject to

agreement with students. If a small number of students wish to take an online course on a specific topic, studying the material with such courses is allowed, but students must complete all the tasks provided in the discipline.

The list of courses is offered by the teacher after the students have expressed a desire (because the bank of available courses is updated almost every month).

The student provides a document confirming the completion of the distance course (in the case of a full course) or provides practical tasks from the distance course and subject to an oral interview with the teacher on the topics can receive grades for control measures provided for the studied topics (express tests, practical work).

Work program of the course (syllabus):

is developed by *Associate Professor of BME, Candidate of Biological Sciences, Svitlana Vovianko.*

Approved by *the Department of Biomedical Engineering (protocol № _1_ to _August, 28, 2021_)*

Approved by *the Methodical Commission of the Faculty of Biomedical Engineering (protocol № __ to _____)*

Appendix 1 to the syllabus of the course "Systemic Physiology"

The list of questions for preparation for the Module Test,

And also for preparation for the Exam

1. *General characteristics of the system approach in physiology*
2. *General properties of living organisms.*
3. *General principles of functioning of the body as a whole.*
4. *The role of correlative relationships in the functioning of the body.*
5. *Regulation in functional systems.*
6. *Reflex and functional systems as a unit of life.*
7. *Functional systems of an organism.*
8. *Principle of self-regulation of physiological functions.*
9. *Functional systems and homeostasis.*
10. *Architectonics of the functional system.*
11. *Isomorphism of functional systems.*
12. *Co-operative interactions of functional systems in an organism.*
13. *Positive and negative feedback in the regulation of the functioning of the human body.*
14. *Selective mobilization of the results of individual bodies and tissues in a holistic organization of a functional system.*
15. *The principle of co-operative interaction in functional systems.*
16. *Hierarchy of functional systems.*
17. *Multi parametric interaction in functional systems.*
18. *Systemogenesis.*
19. *Analysis of the complexity of functional systems.*
20. *An entropy analysis of functional systems.*