

## COURSE SYLLABUS AND COURSE REQUIREMENTS

### ACADEMIC YEAR 2023/24 SEMESTER FALL

<i>Course title</i>	<i>Medical Cybernetics</i>
<i>Course Code</i>	MSM614ANEG
<i>Hours/Week: le/pr/lab</i>	2/2/0
<i>Credits</i>	4
<i>Degree Programme</i>	MSc
<i>Study Mode</i>	
<i>Requirements</i>	
<i>Teaching Period</i>	
<i>Prerequisites</i>	
<i>Department(s)</i>	<i>Institute of Physiology</i>
<i>Course Director</i>	<i>Dr László Péczely</i>
<i>Teaching Staff</i>	<i>Dr. Attila Tóth, Zsolt Kisander, Dr. László Péczely</i>

## COURSE DESCRIPTION

*A short description of the course (max. 10 sentences).*

*Neptun: Instruction/Subjects/Subject Details/Basic data/Subject description*

Cybernetics embracing more disciplines deals with the control, regulation, information flow and processing occurring in expediently working dynamical systems. The most important goal of our subject is to help the students understand the functional principles of the regulatory systems, mainly those of the human body. Furthermore, we would like to familiarize the students with how the balance of the regulatory systems can be maintained by their wide adaptive and learning capacity/capability. We would like to demonstrate that etiology of many diseases can be explained by the disruption of balance, how the balance can be restored by the therapy and, at the same time, how the therapy can cause the shift of the balance in other parts of the system (side effect). In addition to the biological systems, both the functional description of the artificial regulatory systems and the artificial intelligence will be addressed. In the first semester the following topics are discussed: general description of systems, mathematical basics, the concept of homeostasis, biocybernetics of cellular and subcellular structures, mathematical model of the blood coagulation cascade, cardiorespiratory system as regulatory system, neuroendocrine regulation.

## SYLLABUS

*Neptun: Instruction/Subjects/Subject Details/Syllabus*

### 1. GOALS AND OBJECTIVES

*Goals, student learning outcome.*

*Neptun: Instruction/Subjects/Subject Details/Syllabus/Goal of Instruction*

The most important goal of our subject is to help the students understand the functional principles of the regulatory systems, mainly those of the human body. Furthermore, we would like to familiarize the students with how the balance of the regulatory systems can be maintained by their wide adaptive and learning capacity/capability.

### 2. COURSE CONTENT

*Neptun: Instruction/Subjects/Subject Details/Syllabus/Subject content*

## TOPICS

### LECTURE

*1.Introduction to Medical Cybernetics (General definition and description of the systems, living organisms as cybernetic systems, control, feedback regulation, information and entropy: entropy, relative entropy, mutual information) (Péczely László)*

2. *Determination of the input and output parameters of the system, system identification. Black-box and white box modeling, problems of algorithmization (Tóth Attila)*
  3. *Biocybernetics of cellular and subcellular structures, analogies (modeling of membrane processes, integrative description of signal transduction pathways) (Kisander Zsolt)*
  4. *Organs, organ systems, cybernetics of the body I. (muscle) (Kisander Zsolt)*
  5. *Organs, organ systems, cybernetics of the body II. (heart, ECG, blood circulation) (Kisander Zsolt)*
  6. *Organs, organ systems, cybernetics of the body III. (blood: blood coagulation, immune system) (Péczely László)*
  7. *Organs, organ systems, cybernetics of the body IV. (endocrine system) (PéczelyLászló)*
  8. *Models and integrative description of the regulation of motor system, extrapyramidal system (Péczely László)*
  9. *Adaptation, learning and its mathematical models in biological systems (Péczely László)*
  10. *Bionics: translating and applying knowledge gained in biology and medicine to artificial systems (Tóth Attila)*
  11. *Research of analyzers and the problem of imaging methods (Tóth Attila)*
  12. *Cybernetic description of the diagnostic systems: Medical/biological measurement systems (Tóth Attila)*
  13. *System theory approach to therapeutic-diagnostic tools and therapeutic interventions (Tóth Attila)*
- PRACTICE**
1. *The practical possibilities of Medical Cybernetics. Explaining the role of cybernetics through the startle reaction*
  2. *Cybernetics system elements - Feedback I.: Blood sugar measurement, Calculation task based on a clinical model*
  3. *Cybernetics system elements - Feedback II.: Negative feedback. Hormonal regulation, LABORATORY EXERCISE USING "VIRTUAL RATS"*
  4. *Cybernetics system elements - Feedback III.: Positive feedback, blood clotting*
  5. *Cybernetics of muscle I.: Fatigue investigation, Exoskeleton as a cybernetic system*
  6. *Cybernetics of muscle II.: EMG measurement, analysis, clinical significance*
  7. *Heart and Circulation I.: ECG measurement, analysis*
  8. *Heart and Circulation II.: ECG analysis, clinical significance*

9. *Heart and Circulation III.: Measurement, analysis and clinical significance of heart rate variability*
10. *Bioimpedance I.: Cell culture measurements*
11. *Bioimpedance II.: Small animal, human measurements*
12. *Medical imaging procedures: Ultrasound, CT, MRI; Medical decision-making: using practical examples*
13. *Oral report (Grade offer for the practice)*

**LABORATORY PRACTICE**

**DETAILED SYLLABUS AND COURSE SCHEDULE**

ACADEMIC HOLIDAYS INCLUDED

**LECTURE**

week	Topic	Compulsory reading; page number (from ... to ...)	Required tasks (assignments, tests, etc.)	Completion date, due date
1.	<i>Introduction to Medical Cybernetics (General definition and description of the systems, living organisms as cybernetic systems, control, feedback regulation, information and entropy: entropy, relative entropy, mutual information)</i>	1 <sup>st</sup> lecture slides	-	-
2.	<i>Determination of the input and output parameters of the system, system identification. Black-box and white box modeling, problems of algorithmization</i>	2 <sup>nd</sup> lecture slides	-	-
3.	<i>Biocybernetics of cellular and subcellular structures, analogies (modeling of membrane processes, integrative description of signal transduction pathways)</i>	3 <sup>rd</sup> lecture slides	-	-
4.	<i>Organs, organ systems, cybernetics of the body I. (muscle)</i>	4 <sup>th</sup> lecture slides	-	-
5.	<i>Organs, organ systems, cybernetics of the body II. (heart, ECG, blood circulation)</i>	5 <sup>th</sup> lecture slides	-	-
6.	<i>Organs, organ systems, cybernetics of the body III. (blood: blood coagulation, immune system)</i>	6 <sup>th</sup> lecture slides	-	-
7.	<i>Organs, organ systems, cybernetics of the body IV (endocrine system)</i>	7 <sup>th</sup> lecture slides	-	-
8.	<i>Models and integrative description of the regulation of motor system, extrapyramidal system</i>	8 <sup>th</sup> lecture slides	-	-
9.	<i>Adaptation, learning and its mathematical models in biological systems</i>	9 <sup>th</sup> lecture slides	-	-
10.	<i>Bionics: translating and applying knowledge gained in biology and medicine to artificial systems</i>	10 <sup>th</sup> lecture slides	-	-

11.	<i>Research of analyzers and the problem of imaging methods.</i>	11 <sup>th</sup> lecture slides	-	-
12.	<i>Cybernetic description of the diagnostic systems: Medical/biological measurement systems</i>	12 <sup>th</sup> lecture slides	-	-
13.	<i>Localization and state estimation of artificial organisms/systems</i>	13 <sup>th</sup> lecture slides	-	-
14.			-	-
15.				

**PRACTICE, LABORATORY PRACTICE**

<i>week</i>	<b>Topic</b>	<b>Compulsory reading; page number (from ... to ...)</b>	<b>Required tasks (assignments, tests, etc.)</b>	<b>Completion date, due date</b>
1.	<i>The practical possibilities of Medical Cybernetics. Explaining the role of cybernetics through the startle reaction</i>	1 <sup>st</sup> practice slides	-	-
2.	<i>Cybernetics system elements - Feedback I.: Blood sugar measurement, Calculation task based on a clinical model</i>	2 <sup>nd</sup> practice slides	-	-
3.	<i>Cybernetics system elements - Feedback II.: Negative feedback. Hormonal regulation, LABORATORY EXERCISE USING "VIRTUAL RATS"</i>	3 <sup>rd</sup> practice slides	-	-
4.	<i>Cybernetics system elements - Feedback III.: Positive feedback, blood clotting</i>	4 <sup>th</sup> practice slides	-	-
5.	<i>Cybernetics of muscle I.: Fatigue investigation, Exoskeleton as a cybernetic system</i>	5 <sup>th</sup> practice slides	-	-
6.	<i>Cybernetics of muscle II.: EMG measurement, analysis, clinical significance</i>	6 <sup>th</sup> practice slides	-	-
7.	<i>Heart and Circulation I.: ECG measurement, analysis</i>	7 <sup>th</sup> practice slides	-	-
8.	<i>Heart and Circulation II.: ECG analysis, clinical significance</i>	8 <sup>th</sup> practice slides	-	-
9.	<i>Heart and Circulation III.: Measurement, analysis and clinical significance of heart rate variability</i>	9 <sup>th</sup> practice slides	-	-
10.	<i>Bioimpedance I.: Cell culture measurements</i>	10 <sup>th</sup> practice slides	-	-
11.	<i>Bioimpedance II.: Small animal, human measurements</i>	11 <sup>th</sup> practice slides	-	-
12.	<i>Medical imaging procedures: Ultrasound, CT, MRI; Medical decision-making: using practical examples</i>	12 <sup>th</sup> practice slides	-	-
13.	<i>Oral report (Grade offer for the practice)</i>	13 <sup>th</sup> practice slides	-	-
14.			-	-
15.				

### 3. ASSESSMENT AND EVALUATION

(Neptun: Instruction/Subjects/Subject Details/Syllabus/Examination and Evaluation System)

#### ATTENDANCE

In accordance with the Code of Studies and Examinations of the University of Pécs, Article 45 (2) and Annex 9. (Article 3) a student may be refused a grade or qualification in the given full-time course if the number of class absences exceeds 30% of the contact hours stipulated in the course description.

**Method for monitoring attendance** (e.g.: attendance sheet / online test/ register, etc.

attendance sheet

#### ASSESSMENT

Cells of the appropriate type of requirement is to be filled out (course-units resulting in mid-term grade or examination). Cells of the other type can be deleted.

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#### **Course resulting in mid-term grade (PTE TVSz 40§(3))**

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#### **Course-unit with final examination**

#### **Requirements for the end-of-semester signature**

(E.g.: mid-term assessment of 40%)

Attendance of the lectures and practices is mandatory, more than 40% absences implies the refusal of the end-of-semester signature.

#### **Re-takes for the end-of-semester signature** (PTE TVSz 50§(2))

The specific regulations for grade betterment and re-take must be read and applied according to the general Code of Studies and Examinations. E.g.: all the tests and the records to be submitted can be repeated/improved each at least once every semester, and the tests and home assignments can be repeated/improved at least once in the first two weeks of the examination period.

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**Type of examination** (written, oral): oral exam

**The exam is successful if the result is minimum** -  %. (The minimum cannot exceed 40%.)

#### **Calculation of the grade** (TVSz 47§ (3))

In the exam the students have to report 3 topics: 2 theoretical related to the lectures and 1 related to the practice.

#### **Calculation of the final grade based on aggregate performance in percentage.**

In each exam topic the grade should be minimally mark 2 (satisfactory). The final grade is calculated averaging the three subgrades.

### 4. SPECIFIED LITERATURE

In order of relevance. (In Neptun ES: Instruction/Subject/Subject details/Syllabus/Literature)

#### COMPULSORY READING AND AVAILABILITY

[1.] Primary compulsory reading and its availability

Lecture and practice slides are uploaded to the Teams group of the Subject.

[2.] Compulsory literature and its availability

James Kneer, James Sneyd: Mathematical Physiology I.: Cellular Physiology (online available)

James Kneer, James Sneyd: Mathematical Physiology II.: System Physiology (online available)

#### RECOMMENDED LITERATURE AND AVAILABILITY

[3.] Wendell Lim, Bruce Mayer, Tony Pawson: CELL SIGNALING principles and mechanisms (online available)

[4.] Peter Dayan, . F. Abbott: Theoretical Neuroscience (online available)

[5.] .....