COURSE SYLLABUS AND COURSE REQUIREMENTS
ACADEMIC YEAR 2025/26 SEMESTER FALL

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

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 occuring 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, black box and white box modelling) (Attila Tóth)*

2.Bionics: translating and applying knowledge gained in biology and medicine to artificial systems (Attila Tóth)

3.Research of analyzers and the problem of imaging methods (Attila Tóth)

4.Cybernetic description of the diagnostic systems: Medical/biological measurement systems (Attila Tóth)

5.System theory approach to therapeutic-diagnostic tools and therapeutic interventions (Attila Tóth)

6. Biocybernetics of cellular and subcellular structures I. (modeling of membrane processes, resting potential, electrotonic potential, action potential) (Zsolt Kisander)

7. Biocybernetics of cellular and subcellular structures II. (models of the neuron, neuronal communication and networks) (Zsolt Kisander)

8. Biocybernetics of cellular and subcellular structures III. (modeling of signal transduction pathways) (Zsolt Kisander)

9. Biocybernetics of regulatory processes I. (László Péczely)

10. Biocybernetics of regulatory processes II. (László Péczely)

11. Biocybernetics of regulatory processes III. (László Péczely)

12.Adaptation, learning and its mathematical models in biological systems I. (László Péczely)

13.Adaptation, learning and its mathematical models in biological systems II. (László Péczely)

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.	*Introduction to Medical Cybernetics (General definition and description of the systems, living organisms as cybernetic systems, control, feedback regulation, black box and white box modelling)*	1st lecture slides	-	-
2.	*Bionics: translating and applying knowledge gained in biology and medicine to artificial systems*	2nd lecture slides	-	-
3.	*Research of analyzers and the problem of imaging methods Research of analyzers and the problem of imaging methods*	3rd lecture slides	-	-
4.	*Cybernetic description of the diagnostic systems: Medical/biological measurement systemsv*	4th lecture slides	-	-
5.	*System theory approach to therapeutic-diagnostic tools and therapeutic interventions*	5th lecture slides	-	-
6.	*Biocybernetics of cellular and subcellular structures I. (modelling of membrane processes, resting potential, electrotonic potential, action potential)*	6th lecture slides	-	-
7.	*Biocybernetics of cellular and subcellular structures II. (models of the neuron, neuronal communication and networks)*	7th lecture slides	-	-
8.	Autumn break	8th lecture slides	-	-
9.	*Biocybernetics of cellular and subcellular structures III. (modelling of signal transduction pathways)*		-	-
10.	*Biocybernetics of regulatory processes I.*	9th lecture slides	-	-
11.	*Biocybernetics of regulatory processes II.*	10thlecture slides	-	-
12.	*Biocybernetics of regulatory processes III.*	11th lecture slides	-	-
13.	*Adaptation, learning and its mathematical models in biological systems I.*	12th lecture slides	-	-
14.	*Adaptation, learning and its mathematical models in biological systems II.*	13th lecture slides	-	-
15.				

PRACTICE, LABORATORY PRACTICE

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

2. 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.

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

(Eg.: 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.

3. 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
Uri Alon: An Introduction to Systems Biology: Design Principles of Biological Circuits
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.] ……