# COURSE SYLLABUS AND COURSE REQUIREMENTS
# 2022-2023 II.

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|---|---|
| *Course title* | *Human - Machine Interface* |
| *Course Code* | MSM616ANEG |
| *Hours/Week: le/pr/lab* | 2 lectures, 2 practices / week |
| *Credits* | 4 |
| *Degree Programme* | Biomedical Engineering Master |
| *Study Mode* | *Face to face* |
| *Requirements* | Exam |
| *Teaching Period* | Spring |
| *Prerequisites* | |
| *Department(s)* | University of Pécs, Neurosurgery Department, 3D Printing Centre |
| *Course Director* | *Luca Toth* |
| *Teaching Staff* | |

## COURSE DESCRIPTION

*A short description of the course (max. 10 sentences).*
*Neptun: Instruction/Subjects/Subject Details/Basic data/Subject description*

In the course of Human-Machine Interface, students gain insight into development of systems implemented between human (man) - machine, machine – human (man), and how to use them, also the most important applications. Understand the detection and interpretation of neurophysiological signals for control, with particular interest to electroencephalography (EEG), electromyography (EMG), and electroneurography (ENG). Comprehensive knowledge of different control principles and sensors. Basics and application of brain - computer interface. Bionic devices and their significance in bioengineering. Robotic devices and their application. Implantable systems. Knowledge of the basic mechanisms of cerebral plasticity. VR and AR systems.

## 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 goal of the subject is to introduce the students to human – machine interface systems, controls and applications.
- To understand basic control systems and clinical applications
- To get insight to virtual and diagnostic devices applied for clinical research or treatment
- To understand the basics of signal sorting and invasive signal recording

### 2. COURSE CONTENT

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

| | **TOPICS** |
|---|---|
| **LECTURE** | 1. *Basic principles of human – machine interface systems, Introduction to exoskeletons topic*<br>2. *Biomedical engineering and the application of AR and VR systems*<br>3. *Principles of movement analysis systems and application as control for HMI systems*<br>4. *Functional electric stimulation with biomedical engineering applications*<br>5. *Deep brain stimulation and implantable systems for disease modification*<br>6. *Transcranial magnetic stimulation as a potential therapeutic system for neurologic diseases*<br>7. *Monitoring the activity of large neuronal populations with high spatiotemporal resolution*<br>8. *Invasive brain monitoring for therapeutic target in the intensive care unit*<br>9. *Neurorehabilitation with robotic devices*<br>10. *EEG, quantitative EEG, EEG signal processing, fMRI human machine interface*<br>11. *3D printed systems and bionic prosthetics for HMI* |

**PRACTICE & LABORATORY**

1. *Basic principles of human – machine interface systems, Introduction to exoskeletons topic*
2. *Biomedical engineering and the application of AR and VR systems*
3. *Principles of movement analysis systems and application as control for HMI systems*
4. *Functional electric stimulation with biomedical engineering applications*
5. *Deep brain stimulation and implantable systems for disease modification*
6. *Transcranial magnetic stimulation as a potential therapeutic system for neurologic diseases*
7. *Monitoring the activity of large neuronal populations with high spatiotemporal resolution*
8. *Invasive brain monitoring for therapeutic target in the intensive care unit*
9. *Neurorehabilitation with robotic devices*
10. *EEG, quantitative EEG, EEG signal processing, fMRI human machine interface*
11. *3D printed systems and bionic prosthetics for HMI*

## DETAILED SYLLABUS AND COURSE SCHEDULE

*ACADEMIC HOLIDAYS INCLUDED*

***LECTURE & PRACTICE***

| *week* | **Topic** | **Compulsory reading; page number (from … to …)** | **Required tasks (assignments, tests, etc.)** | **Completion date, due date** |
|---|---|---|---|---|
| *1.* | Basic principles of human – machine interface systems<br>Introduction to exoskeletons | Jocelyne Troccaz - Medical Robotics, 2013, ISBN-10: 1848213344 | To plan a HMI system | 13th week |
| *2.* | Biomedical engineering and the application of AR and VR systems | Chang S. Nam, Anton Nijholt, Fabien Lotte - Brain–Computer Interfaces Handbook: Technological and Theoretical Advances, 1st Edition. ISBN 9781498773430 - CAT# K29559 | | |
| *3.* | Principles of movement analysis systems and application as control for HMI systems | Jocelyne Troccaz - Medical Robotics, 2013, ISBN-10: 1848213344 | | |
| *4.* | Functional electric stimulation with biomedical engineering applications | Chang S. Nam, Anton Nijholt, Fabien Lotte - Brain–Computer Interfaces Handbook: Technological and Theoretical Advances, 1st Edition. ISBN 9781498773430 - CAT# K29559 | | |
| *5.* | Deep brain stimulation and implantable systems for disease modification | Chang S. Nam, Anton Nijholt, Fabien Lotte - Brain–Computer Interfaces Handbook: Technological and Theoretical Advances, 1st Edition. ISBN 9781498773430 - CAT# K29559 | | |
| *6.* | Transcranial magnetic stimulation as a potential therapeutic systems for neurologic diseases | Chang S. Nam, Anton Nijholt, Fabien Lotte - Brain–Computer | | |

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|---|---|---|---|---|
| | | Interfaces Handbook: Technological and Theoretical Advances, 1st Edition. ISBN 9781498773430 - CAT# K29559 | | |
| *7.* | Monitoring the activity of large neuronal populations with high spatiotemporal resolution | Chang S. Nam, Anton Nijholt, Fabien Lotte - Brain–Computer Interfaces Handbook: Technological and Theoretical Advances, 1st Edition. ISBN 9781498773430 - CAT# K29559 | | |
| *8.* | Invasive brain monitoring for therapeutic target in the intensive care unit | Chang S. Nam, Anton Nijholt, Fabien Lotte - Brain–Computer Interfaces Handbook: Technological and Theoretical Advances, 1st Edition. ISBN 9781498773430 - CAT# K29559 | | |
| *9.* | Neurorehabilitation with robotic devices | Jocelyne Troccaz - Medical Robotics, 2013, ISBN-10: 1848213344 | | |
| *10.* | Consultation on Project work | Chang S. Nam, Anton Nijholt, Fabien Lotte - Brain–Computer Interfaces Handbook: Technological and Theoretical Advances, 1st Edition. ISBN 9781498773430 - CAT# K29559 | | |
| *11.* | EEG, quantitative EEG, EEG signal processing, fMRI human machine interface | Chang S. Nam, Anton Nijholt, Fabien Lotte - Brain–Computer Interfaces Handbook: Technological and Theoretical Advances, 1st Edition. ISBN 9781498773430 - CAT# K29559 | | |
| *12.* | 3D printed systems and bionic prosthetics for HMI | Jocelyne Troccaz - Medical Robotics, 2013, ISBN-10: 1848213344 | | |
| *13.* | Presentation of the project work | | Presentation of assigned HMI system planning | |
| *14.* | Test | | | |
| *15.* | Re-Test taking opportunity | | | |

## 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.*

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

***Mid-term assessments, performance evaluation and their ratio in the final grade*** *(The samples in the table to be deleted.)*

| Type | Assessment | Ratio in the final grade |
|---|---|---|
| *Home assignment* | *max. 25 points* | *25%* |
| *Test* | *Max 30 points* | *75%* |

***Opportunity and procedure for re-takes*** (PTE TVSz 47§(4))

*The specific regulations for improving grades and resitting tests must be read and applied according to the general Code of Studies and Examinations. E.g.: all tests and assessment tasks can be repeated/improved 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.*

On the last, 15th week there will be opportunity to present the assigned HMI system presentation or a test re-take opportunity

***Grade calculation as a percentage***

*based on the aggregate performance according to the following table*

| Course grade | Performance in % |
|---|---|
| excellent (5) | 85 % < |
| good (4) | 70 % - 85 % |
| satisfactory (3) | 55 % - 70 % |
| pass (2) | 40 % - 55 % |
| fail (1) | below 40 % |

The lower limit given at each grade belongs to that grade.

## 4. SPECIFIED LITERATURE

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

**COMPULSORY READING AND AVAILABILITY**

- Jocelyne Troccaz - Medical Robotics, 2013, ISBN-10: 1848213344
- Kevin C Chui, Sheng-Che Yen, Milagros Jorge, Michelle M. Lusardi - Orthotics and Prosthetics in Rehabilitation, 4th edition
- Chang S. Nam, Anton Nijholt, Fabien Lotte - Brain–Computer Interfaces Handbook: Technological and Theoretical Advances, 1st Edition. ISBN 9781498773430 - CAT# K29559
- Dietz, Volker, and Nick S. Ward (eds), Oxford Textbook of Neurorehabilitation, 2 edn, Oxford Textbooks in Clinical Neurology (Oxford, 2020; online edn, Oxford Academic, 1 May 2020), https://doi.org/10.1093/med/9780198824954.001.0001, accessed 26 Jan. 2023.