Medical Engineering for Space and Earth

Educational subject description sheet

Basic information

Field of study AGH UST International Courses **Speciality** All **Department** Generic subjects **Study level** any level **Study form** Full-time studies **Education profile** General academic	**Didactic cycle** 2022/2023 **Subject code** POGJOS.A100000O.624edc390abc3.22 **Lecture languages** English **Mandatory** Elective **Block** General Modules **Subject related to scientific research** No **USOS code** 120-INT-xS-224

Subject coordinator	Mateusz Danioł
Lecturer	Mateusz Danioł

Period Winter semester	**Examination** Assessment **Activities and hours** Lecture: 20, Project classes: 10	**Number of ECTS points** 3.0

Goals

C1	Understanding the need of personal health monitoring in space environment, from medical and technological perspective
C2	Recognization the different sensors and medical technologies for human health monitoring and conducting a research in space environment
C3	Understanding of space-related environmental factors affecting medical devices in space
C4	Understanding of the importance of GDPR, patent protection and ethical aspects of medical engineering applications in space
C5	Integrate the transdisciplinary knowledge (basics of physiology and psychology, technical knowledge of sensing technologies and data processing) to form a general design of personalized health system for manned space missions

Subject learning outcomes

Code	Outcomes in terms of	Directional learning outcomes	Examination methods
Knowledge – Student knows and understands:			
W1	Student knows main aspects of space environment for humans and the technological inventions towards space exploration		Activity during classes
W2	Student knows and understands the main hazards and challenges for humans in the aspects of physiological, psychological body response		Activity during classes
W3	Student understands the main measurable parameters and indicators of body response to space environment		Activity during classes
W4	Student understands and identifies the space mission safety concerns coming from increased stress		Activity during classes
W5	Understands the main stress indicators, recognizes physiological stress indicators and methods of its measurement in space like EEG, skin conductance, biomarkers, etc.		Activity during classes
W6	Understands the effects of chronic stress on space manned missions, recognizes the methods of chronic stress measurement and management, especially the data collection techniques, digital assistants for stress management, telemedicine, self-evaluation smartphone apps, AI based expert systems		Activity during classes
W7	Student understands the concept of mobile device being a personal point-of-care, understands the concept of data collection using mobile device, its limitations, challenges and perspectives		Activity during classes
W8	Student understand the importance of ethical issues related to space manned missions, intellectual property rights related to space medical devices, and GDPR which applies to the data collected while the mission		Activity during classes
W9	Student knows and understand the basic wearable devices and sensors possible to use while manned space missions		Activity during classes

Skills – Student can:			
U1	Student can define, understand and classify the main risks affecting medical electronics in space, understnads the differences and design considerations between the “on-earth” devices and the space ones		Activity during classes
U2	Student can identify the challenges for telemedicine in space, proposes the solutions to overcome the technical issues and ideas for telemedical applications for astronauts		Activity during classes
Social competences – Student is ready to:			
K1	Student is ready to work in international interdisciplinary teams working on specific case studies		Activity during classes

Programme content that ensure achieving learning outcomes for the module

The course focuses on the medical technologies which are currently in use and on technologies which might make the long-term space-flights possible in the near future. In the course all the aspects are presented from the general to the specific manner through several practical scenarios. Thanks to this course structure, students can easily imagine the practical application of the specific topics covered later in the course. The course is structured to stimulate the imagination and inspire further development towards space medical technologies in a pragmatic and interdisciplinary manner.

Calculation of ECTS points

Activity form	**Average amount of hours* needed to complete each activity form**
Lecture	20
Project classes	10
Participation in classes / practical placement	30
Preparation for classes	10
Preparation of project, presentation, essay, report	20
Student workload	**Hours** 90
Workload involving teacher	**Hours** 30

* hour means 45 minutes

Study content

No.	**Course content**	**Subject learning outcomes**	**Activities**

1.	Importance of the medical technology and its binding to medicine and space flights • Humankind inventing technology towards space • Space Environment	W1	Lecture
2.	The environment and hazards of the space flight and human body response • Physiological parameters and measurable indicators • Psychological parameters and measurable indicators	W2	Lecture
3.	Case study – Stressful Critical Events – Physiological Perspective • Mission safety concerns • Physiological stress indicators • Physiological sensors	W3, W4, W5, K1	Lecture, Project classes
4.	Case study – Chronic stress and psychological disorders • Safety concerns originated from increased stress level • Stress indicators and data collection techniques • Space flight stress and state of analogous (Analysis of Mars500 experiment) • Technical areas of stress management	W3, W4, W5, W6, K1	Lecture, Project classes
5.	Space environment affecting the medical devices, requirements and constraints from the work environment • Radiation affecting sensors and electronic devices • Communication with mission control • Electromagnetic distortions • Crew training & motivation maintenance • Risk assessments	U1	Lecture

6.	Wearable technologies in space – applications, challenges and further development • Concept of astronaut being a “Point-of-care” • Disruptive technologies for the future of space medicine: AI, algorithms, robotics, virtual and augmented reality • Gamification – improving compliance and monitoring, motivation • Health sensors ◦ Cardiac sensors - one/multi channel ECG, pulse meter, blood pressure ◦ EEG ◦ Blood Oxygen Level ◦ Body temperature, skin conductance ◦ Ultrasound ◦ Vision monitoring with Optical Coherent Tomography ◦ Actimetry ◦ Speech analysis ◦ Cortisol and other hormones, biomarkers ◦ Other monitoring techniques	W3, W4, W5, W6, W9	Lecture
7.	Mobile devices in space – personalized healthcare in Space Station • Smartphone as personal medical hub – chances, limitations, opportunities	W7, W9	Lecture
8.	Ethics, Data Collecting Regulations and Intelectual Property Issues in the context of manned space missions	W8	Lecture
9.	Telemedicine and automated data analysis for space and earth applications	U2	Lecture

Course advanced

Teaching methods:

Design thinking, E-learning, Discussion, Lectures

Activities	Examination methods	Credit conditions
Lecture	Activity during classes	
Project classes	Activity during classes	

Method of calculating the final grade

Based on the student's activity during lectures and classes

Entry requirements

This course is designed for non-specialists and will offer an introduction to the medical engineering in space environment – its basics, use-cases, challenges and overview of technological possibilities. A basic knowledge of human anatomy and physiology is appreciated, basics of technical sciences will be very welcomed. Basics of programming will be helpful.

Attendance requirements for particular classes, with indication whether student attendance is compulsory

Both lectures and project classes are obligatory.

Literature

Obligatory

1. Trailblazing Medicine, Erik Seedhouse, Springer, 2011

Optional

1. Space Physiology and Medicine - From Evidence to Practice, Arnauld E. Nicogossian, Richard S. Williams, Carolyn L.2. Huntoon, Charles R. Doarn, James D. Polk, Victor S. Schneider, Springer-Verlag, 2016
2. Wearable Sensors - Fundamentals, Implementation and Applications, Edward Sazonov, Elsevier, 2020