

Topics for the Final state examination (FSE) in the master's study degree program
N0914A360002 BIOMEDICAL AND CLINICAL ENGINEERING

According to Article 7, paragraph 3 of the Dean's directive for the implementation of bachelor and master degree study programs at the Czech Technical University in Prague - Faculty of Biomedical Engineering Dean sets based on proposal by the head of the Department of Biomedical Technology thematic areas listed below.

Topics are designed in accordance with the valid accreditation approved by Ministry of Education, Youth and Sports on the April 17th 2020 Ref.: NAU-365/2019-9.

Topics are designed as the minimum required knowledge (theoretical and practical), which are necessary for successful graduate in practice. At the end of the thematic areas the names of the mandatory courses are summarized for better orientation of students. On the basis of paragraph 3 of Article 7 of the above mentioned Dean's Directive is mandatory for the student 3 mentioned areas. During the final state examination student gets assigned at least three questions from each thematic area. There are also allowed issues that are directly related to the theme of the Master's project (thesis). Questions enter committee members, or a member of the committee determined by the chairman. Answers to the questions should follow immediately after their entering and without a written preparation.

1) Theory, methods and procedures of signal and image processing and application of natural science disciplines in biomedical engineering

General mechanisms of physiological regulation, positive and negative feedback, and the role of hormones; membrane transport, membrane potential, and action potential; cardiovascular physiology and cardiac electrophysiology; immunity.

Measurement methods in experimental biomechanics; description and evaluation of movement; materials in biomechanics and their properties, biomaterials, biocompatibility, bioactive materials, composites, and sterilization techniques.

Confidence intervals; hypothesis testing, type I and type II errors, p-value, and power of a statistical test; statistical significance and practical significance; one-sample t test, and two-sample t test for paired data and for independent data; analysis of variance (ANOVA); sensitivity and specificity of a diagnostic test; correlation and linear regression.

Digital signal, A/D conversion and sampling; Fourier transform (FT, FS, DTFT, DFS, FFT), amplitude, power, and phase spectrum; digital filtering, finite impulse response (FIR) filters and infinite impulse response (IIR) filters.

Relevant courses: Systemic Physiology, Biomechanics and Biomaterials, Mathematical Methods in Research, Digital Signal Processing.

2) Medical instrumentation and medical devices in biomedicine

Blood pressure measurement; pulse oximetry; electrocardiography (ECG); electroencephalography (EEG); monitors of vital signs, overview of the biosignals; defibrillators and pacemakers. Operating tables and operating room equipment, infusion equipment.

Ultrasound imaging systems and Doppler ultrasound; computed tomography; single-photon emission computed tomography (SPECT) and positron emission tomography (PET); Magnetic resonance (MR) - technical principle.

Blood gases, their measurement and interpretation, normal values of arterial blood gases; principles and adverse effect of mechanical lung ventilation; principles of protective lung ventilation; extracorporeal

membrane oxygenation (ECMO); anesthesia machine and variable-bypass vaporizer; measurement of cardiac output.

Relevant courses: *Medical Devices and Equipment, Imaging Systems in Medicine, Equipment for Anesthesia and Critical Care.*

3) Legal, economic and managerial topics in healthcare and research methodology.

Principles of Medical Device Regulation (EU Regulation 745/2017); process of placement of medical devices to the market; classification of medical devices (risk-based system); post-market surveillance; Placing a medical device on the market in and outside the EU.

Basic structure of a research article and purpose and specifics of each of its parts; information sources, publishing ethics, and peer-review process; principles and design types of research studies; informed consent and ethical requirements for clinical trials.

Relevant courses: *European Legislation and Management in Health Care, Methodology of Research and Information Sources.*

Approved by the Board of the Biomedical and Clinical Engineering Program on September 25, 2025.

Kladno, 5th January 2026

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