LIST OF QUESTIONS AND TOPICS FOR THE DIPLOMA EXAM

Field of study: Biomedical Engineering
Second-cycle studies

Modules:
(A) – basic module (mandatory for all specializations)
(B) – specialization "Modern Technologies and Structures for Medicine"
(C) – specialization "Computer Science in Medicine"

MODULE A

1. Explain what the Turing test is. What is it used for?

2. Present the measures used to evaluate the quality of a classifier.

3. List the features of biomedical signals that are a prerequisite for using artificial intelligence in biomedical engineering.

4. Explain the concepts of biocybernetics, model, and computer simulation.

5. Provide a method for verifying the effectiveness of a model developed using machine learning.

6. Give examples of biocybernetic models.

7. Discuss what data mining is and what its methods are.

8. List and characterize examples of research methods, techniques, and tools. Describe the sources of variability in research results.

9. Characterize the methods for verifying parametric statistical hypotheses.

10. Characterize the methods for verifying nonparametric statistical hypotheses.

11. Discuss the methodology of building a geometric model of a selected anatomical element (e.g., femur) based on computed tomography results.

12. Explain what the finite element method is. Give an example of the application of the finite element method in biomedical engineering.

13. Explain the concept of using the inverse dynamics problem in the numerical simulation of the human musculoskeletal system.

14. Describe the process of building a geometric anatomical model using computed tomography images.

15. Describe the process of modeling and numerical analysis of a selected anatomical object using the finite element method.

16. List the elements that should be included on the instructional and technological chart.

17. Characterize the electro-discharge machining process.

18. Discuss modern methods of sintering implant materials: MIM, SPS, HIP.

19. Present the advantages and disadvantages of selective sintering methods: SLS and SLM.

20. Compare laser, plasma, and electron beam cutting (welding) methods.

21. Present the technological process of manufacturing a hip joint endoprosthesis.

22. Discuss the method of obtaining polyethylene (UHMWPE) using the Arcom method.

23. Explain the concepts: greenhouse effect, ozone hole, and their impact on the environment.

24. Describe methods for the disposal of medical waste.

25. Explain the concept of 'biomimetics' and give examples of biomimetic materials.

26. Characterize nanomaterials and nanotechnologies in medicine.

27. Discuss shape memory materials in medicine. Explain the superelasticity effect.

28. Discuss methods for in vitro and in vivo biocompatibility testing of biomaterials.

29. List and discuss modern methods for structural testing of biomaterials.

30. List and briefly characterize the methods of data acquisition in computer-aided dentistry.

31. Present the basic types of medical imaging, including their application in medicine.

32. Discuss the use of 3D printing in planning and assisting surgical operations.

MODULE B: Modern structures and technologies for medicine

1. Implants used in spinal surgery – discuss the basic types and present selected examples of design solutions.

2. Fixation of endoprosthesis elements using bone cement and cementless fixation – discuss and compare design, biomechanical, and operational aspects.

3. Hip joint endoprosthesis – discuss the basic design variants and their components.

4. Knee joint endoprosthesis – discuss the basic design variants and their components.

5. Shoulder joint endoprosthesis – discuss the basic design variants and their components.

6. Discuss the design and operating principle of an example dry test for rapid medical diagnostics.

7. Discuss the design and operating principle of a biosensor. Discuss the types of biosensors based on the bioreceptor used.

8. Discuss the application of biosensors in medical diagnostics.

9. Characterize the design, operating principle, and application of biochips.

10. How do immunological biosensors (immunosensors) work and in what analyses can they be used?

11. Discuss the design and operating principle of an SPR biosensor. Describe the possibilities for practical applications of SPR biosensors.

12. Cytoskeleton of a eukaryotic cell – describe its structure and role in cell functioning.

13. Discuss the structure of bone tissue, from the molecular level to the macrostructure.

14. Discuss the properties of bone tissue and the methodology for testing them.

15. Explain the influence of mechanical factors on the growth, union, and remodeling of bone tissue.

16. Cartilage tissue – describe its structure, types, and properties.

17. Tendons and ligaments – describe their structure and mechanical properties.

18. Describe the basic properties of mesenchymal cells and present techniques for mechanical stimulation of cells.

19. Describe the influence of mechanical factors on the functional adaptation of bone tissue.

20. Discuss the process of callus formation and the influence of mechanobiological factors on the bone union process after a diaphyseal fracture of a long bone.

21. Characterize PVD methods of coating deposition.

22. Characterize CVD methods of coating deposition.

23. Describe the method of producing coatings using the sol-gel method.

24. Describe the method of shaping surface microstructure using photolithography.

25. Characterize the shaping of surface layers using laser technologies.

MODULE C: Computer Science in Medicine

1. What is the alignment of nucleotide sequences and what is its purpose?

2. Present one of the algorithms for global sequence alignment.

3. What is the Central Dogma of Molecular Biology? Discuss its individual stages.

4. What are genetic databases? How can information be retrieved from these databases?

5. What is phylogenetics? Present the idea behind constructing a phylogenetic tree.

6. List a few examples of potential applications of mobile devices in biomedical engineering.

7. What are the constituent components of an application in Android? Present their brief characteristics.

8. List and briefly describe Activity states in Android.

9. Describe the MVC design pattern used in the Android system.

10. Present the types of Services in the Android system.

11. Explain the concept of object-oriented programming. Define the terms: class and object.

12. List and discuss selected data processing modules in Python.

13. What are regular expressions for and how can they be used in Python? Give an example of using regular expressions.

14. List and characterize popular Python 'Connectors' for relational databases.

15. List and characterize popular Python 'Connectors' for non-relational databases.

16. Explain the concept of data mining. Briefly characterize the basic steps of a general data mining algorithm.

17. Explain the concept of a rule, and the concepts of support and confidence for a rule.

18. List and characterize basic classification methods.

19. Discuss the operating principle of algorithms for discovering frequent patterns and strong association rules. Discuss the Apriori algorithm.

20. List and characterize basic clustering methods.

21. Present and briefly describe the main problems associated with machine learning.

22. List and describe the layers used in convolutional neural networks.

23. Explain the concept of transfer learning.

24. Present a selected neuron activation function used in deep neural networks.

25. List and describe the known regularization methods used in training neural networks.