No calculators allowed.
Each problem yields maximally 20 points. To pass the exam, you must get in total at least 40 points. Answer briefly (maximum 1 page/whole question) with few sentences in each question.

1.a) Heart failure is one of the leading causes of death in the world. Explain briefly what the heart failure is. Give technological solutions to diagnose and treat the heart failure.

b) Briefly explain five different sub-branches of biomedical engineering: their study goals, study methods and applications.

c) Characterize some important general problems or challenges in the development of medical devices. Why is it so hard and expensive to develop and manufacture these medical devices?

2.a) Explain the role and importance of a sensor in medical measurements.

b) You should select a proper sensor to different measurement applications. Briefly describe and argue your choice of sensor and measurement principle for the following applications:

b1) measurement of the body movement of the patient in bed during sleep

b2) blood flow velocity measurement from an artery

b3) heart rate measurement from an ambulatory (moving) patient

b4) continuous core body temperature measurement

3.a) Describe the standard 12-lead ECG system.

b) Describe the typical, normal ECG signal and typical changed caused by a third degree (complete) AV block and atrial tachycardia (atrial flimmer or flutter)

c) Describe the EEG signal and different methods to record it.

4. Briefly explain the following concepts and their importance in medical imaging:
   a) Attenuation coefficient
   b) Acoustic impedance
   c) CT
   d) Larmor frequency
   e) PET and SPECT