UNIVERSITY OF OSLO

Faculty of Mathematics and Natural Sciences

Exam in FYS 4250/9250
Day of exam: 7. October 2020
Exam hours: 09.00 – 12.00 (3 hours)
This examination paper consists of 3 page(s).
Appendices: None
Permitted materials: All written, published and electronic materials

Exercise 1

a. An action potential in the myocard (heart cell) is the beginning of a contraction of the heart muscle. What is an action potential, what triggers the action potential and what stops it?

b. The electrical activity of the heart can be measured by means of electrodes and an ECG-monitor. Which electronic components would you use in the ECG-device, and why?

c.

Figure 1. The Apple Watch with an ECG-function (source: https://www.iphonefirmware.com/wp-content/uploads/2018/12/watchOS-5.1.2-for-Apple-Watch-now-available-with-ECG-app-new-Infograph-complications-more-iphonefirmware-com.jpg)

In figure 1, you can see an example of a smart watch that is equipped with electrodes for ECG measurements. Is it possible to take a decent ECG-measurement with electrodes located on the watch only? If it is possible, explain how. Which lead will this represent in the standard Einthoven-triangle?

d. If you would like to redesign the smart watch in order to make a so-called "unipolar" measurement, what would you need to do?

Exercise 2

a. Choose a suitable method for measuring the minute-volume (= cardiac output) of the heart, and describe briefly the principles of the method

b. Figure 2 shows a pulmonary artery catheter that can be used for indicator cardiac output measurements. Explain briefly:

   i. How we can make sure that the catheter is correctly positioned without image guiding?
   ii. How is it possible to measure the cardiac output (= the blood volume from the left ventricle) when the catheter is located in the pulmonary artery?

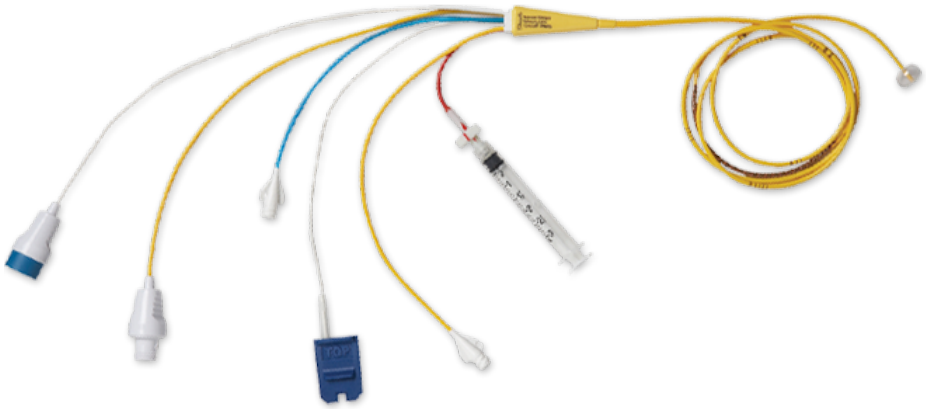

Figure 2. A pulmonary artery catheter (Source: Edwards Lifesciences)

c. There are two dominating methods for indicator measurements of cardiac output: Thermodilution and dye-dilution. Explain why you need to puncture the artery with the dye-dilution method, in opposition to the thermodilution method.

d. The catheter is equipped with a thermistor at the cathetertip. Explain why a thermistor in the bloodstream might be problematic, and how you can design

a circuit that will provide constant current to the thermistor when measuring the output of the thermistor.

Exercise 3

a. Describe the most important differences between a regular X-ray tube and a CT-tube, and explain why these differences are important.

b. Explain briefly how a CT-image is created, the most relevant source of error and measures that can be taken to counteract this

c. Name the two main image reconstruction methods, explain briefly the basic differences and main strengths and weaknesses of each

Exercise 4

a. Give one examples of how we can use ultrasound for diagnostic procedures, and one example for therapeutic procedures.

b. Describe briefly the difference between an ultrasound blood pressure monitor, and an oscillometric blood pressure monitor. Which of the two methods is most suitable for measuring pathological low blood pressures (= hypotensive blood pressure), and why?

Make sure that your copy of this examination paper is complete before answering.