ELT-61216 Biomedical Engineering: Signals and Systems
Exam 16.10.2014/ Juha Nousiainen

No calculators allowed.
Give brief and compact answers in each question.

1.a) **Explain** what are the *open-loop* and *closed-loop* control systems. **Describe** an example of a closed-loop control system in the body and an example where it is used medical devices controlling some physiological function.

b) **Explain** why you should be as a biomedical engineer aware of noise and variability in physiological measurements? **Explain** how the noise and signal variability can be originated in the measurements, use ECG as an example?

2. Related to physiological measurement systems:

a) **Explain** the principles of strain gage sensor and **give** applications how it is used in medical measurements.

b) **Explain** what kind of sensor is used in physiological **ultrasound** measurements. Give applications of these ultrasound measurements.

c) The cardiac output of the heart is usually measured by an *indirect* method. **Explain,** what does is mean. **Describe** an example of one indirect method to measure the cardiac output of the heart.

3. Consider the ECG and answer the following questions.

a) **Describe** a typical ECG signal wave form, **name** its components and **argue** why this typical wave forms is usually observed.

b) **Explain** what is a *bipolar* and *unipolar* lead in biopotential recording in general and in the 12-lead ECG system in particular.

c) **Describe** how you can model the generation of the ECG.

4. Related to the medical imaging systems:

a) **Explain** what is medical *tomography* imaging? What kinds of tomography imaging modalities are in clinical use?

b) **Explain** why *ultrasound* imaging is so popular in medical practice?

c) **Explain** the meaning of the Larmor frequency?