

## **BME-2626 Processing of Physiological Signals**

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### **Examination 22.5.2013**

No materials are allowed, the examination is a closed book examination.

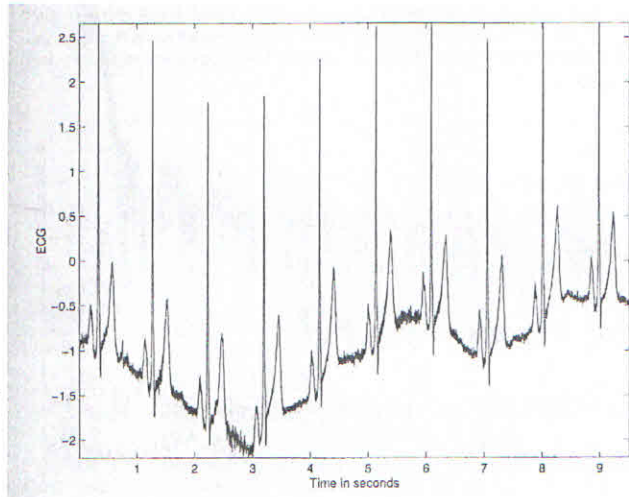
No calculators, computers or alike are allowed.

Maximum number of points for this examination is 70 points.

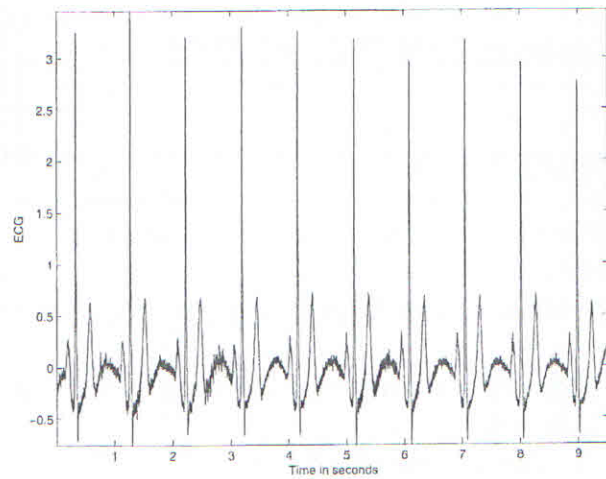
#### **NOTE: There are two pages of questions in this examination.**

1. Describe concisely with one to three sentences the following concepts or matters (max. 2 points each):
  - a) Electromyogram
  - b) Heart beat morphology
  - c) The difference between unipolar and bipolar EEG measurements
  - d) Wave delineation in ECG processing
  - e) Aliasing
2. What does ensemble averaging mean and in what kind of situations in biomedical signal processing it can be used? Also, briefly describe an application of ensemble averaging. (10 points)
3. Describe the principles of independent component analysis and how to use it in biomedical signal processing. (10 points)
4. Heart rate variability. (10 points)
5.
  - a) List sources or types of noises or artifacts of different physiological or physical origin encountered in biomedical measurements. (1 point per source or type, max. 5 points)
  - b) List bioelectric measurements or signals of different origin. (1 point per measurement or signal, max. 5 points)
6. Describe least mean square adaptive filtering (LMS filtering) giving also the algorithm with equations. Also describe in what kind of cases in biomedical signal processing it can be used? (10 points)

7. In Fig. 1A you can see an ECG signal with an artifact. What is the artifact called? What could be possible causes of the artifact? How to process the signal in Fig. 1A to alleviate the artifact and to get the signal processing result seen in Fig. 1B? (max. 10 points)



(A)



(B)

Fig. 1 (A) An ECG signal with an artifact. (B) The signal seen in (A) after processing.