Tfy-99.3275 – Biosignal Processing

Exam 11.01.2013

For each question a maximum of 6 points can be earned (thus: 5 * 6 = 30 points in total). Points that you possibly earned by doing exercises will be added.

You may answer the questions in English as well as in Finnish.

1.

a) Give two examples of *bioelectric* signals, and for each of them state whether they are random (yes/no), transient (yes/no) and periodic (yes/no). (2p)

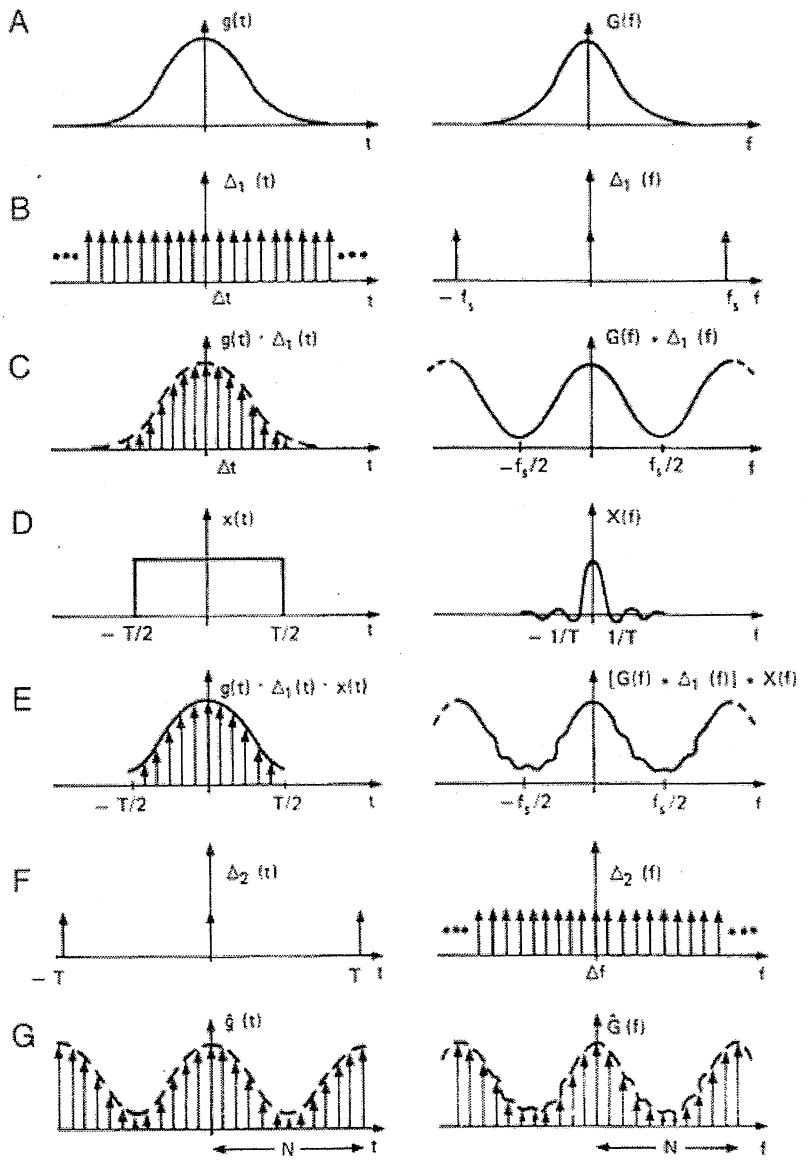
b) The sampling theorem is well-known by most engineers. Still, we see that sometimes it is violated in practice and an incorrect sampling rate is used. Give *two* reasons (in a biosignal processing application) why this might happen. (2p)

c) Describe what the terms *causality* and *stability* mean. (2p)

2.

a) What do we mean with the phase response of a filter? (1p). What does it mean in practice for a (bio)signal processing task when we state that a filter we use has a 'linear phase response'? (1p)

b) Describe the different steps the Discrete Fourier Transform (DFT) contains and what kind of effect they have on the signal that is being processed. You may use the picture below as help. (4p)



3.

a) A researcher designs an artefact-detection algorithm for EEG signals on the basis of a few publicly available EEG 'normal subject' data records that are known to be artefact-free. Using this data he derives as detection limits [mean-3*standard deviation, mean+3*standard deviation] employing the idea that in such case about 99.7% of artefact-free data will be accepted for further processing. However, upon trying out the algorithm in a 'real-life' situation in a hospital, the results are disappointing – many false alarms (false artefact detections) are generated. Give *three* possible reasons why this could happen. (3p)

b) Describe the principle of a *matched filter*: when do we use it, what does the impulse response of such a filter look like, and give a biosignal processing application example of such a filter. (3p)

4.

a) Measuring data over long-term during daily living has as typical problem that one has to deal with missing data. Describe one way to calculate the power spectral density of a signal that has missing data. (2p)
b) Describe how a return map (Poincaré plot) is constructed. Give a detailed example of its usage. (2p)
c) Explain what is meant with 'segmentation of a signal', and describe one example of a way to perform segmentation. (2p)

5.

a) Draw an example of a ROC curve (and label the axes correctly) (1p). Give *two* application examples of how we could use such a ROC curve. (2p)
b) Suppose you have built a system that is to classify between normal/healthy people and people with heart problems (cardiac failure). When you test it you get the following confusion matrix.

true patient state patient state according to developed system	normal	cardiac failure
normal	882	23
cardiac failure	71	413

What are the sensitivity, specificity, accuracy, and positive and negative prediction values of this system? (2p)
Explain what the term *positive prediction value* means in practice (1p).

[END]