

ENEL 563 Biomedical Signal Analysis
Fall 2008
Assignment 2

Question 1: Identify one source each of random noise and physiological artifact that could corrupt a heart sound signal. Suggest steps to prevent the artifacts you identify at the time of acquisition of the signal. (2 marks)

Question 2: A signal $y(t)$ is observed as $y(t) = a x(t - t_1) + s(t)$, where $x(t)$ is a signal of interest, a is a scalar, t_1 is a delay in time, and $s(t)$ is an artifact.

Write the definition of the Fourier transform of a continuous-time signal.

Derive an expression for the Fourier transform of $y(t)$ and explain how it is related to the Fourier transforms of $x(t)$ and $s(t)$. Show all steps of your derivation. (4 marks)

Question 3: Given a signal $x(t)$, give the definition of the time-averaged autocorrelation function (ACF) $\phi(\tau)$.

Derive the relationship between the Fourier transforms of $x(t)$ and $\phi(\tau)$. Show all steps of your derivation. Provide an interpretation of your result. (4 marks)

Question 4: Two linear, shift-invariant, discrete-time filters are specified in terms of their impulse responses as

$$\delta(n) - \delta(n - 1); \text{ and}$$

$$\delta(n) + \delta(n - 1) + \delta(n - 2).$$

A researcher prepares a new filter by connecting the two filters described above in series.

- (a) Derive the transfer function of each filter. (1 mark)
- (b) Derive the transfer function of the combined filter. (1 mark)
- (c) Derive the impulse response of the combined filter. (1 mark)
- (d) Does it matter which filter is placed first? Explain and justify your answer. (1 mark)
- (e) Draw the signal-flow diagram of the combined filter. (2 marks)
- (f) Draw the pole-zero diagram of the combined filter. (2 marks)
- (g) What is the gain of the combined filter at DC, $f_s/4$, and $f_s/2$, where f_s is the sampling frequency? Give an interpretation of the nature of the combined filter. (2 marks)

Solve all parts of this problem by hand and show all steps.

(Total marks for this problem: 10)

Total marks: 20. Due date: 4:00 PM, Friday, 31 October, 2008, in the box for ENEL 563, 2nd floor, ICT building.
