Heriot-Watt University
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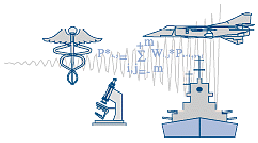

Tutorial 2

Digital Signal Processing

1. Compute the 5 point DFT of the sequence x(n) given below.

n	0	1	2	3	4
x(n)	1	1	2	3	3

2. Two 3 point sequences $x_1(n)$ and $x_2(n)$ are given below. Sketch and label all values for the following:

(a) $x_1(n) * x_2(n)$

(b) $x_1(n) * x_2(n)$

(c) $Rx_1x_2(p)$

(d) $Rx_1x_1(p)$

(e) $Rx_1x_1(p)$

n	0	1	2
$x_1(n)$	1	3	-2

n	0	1	2
$x_2(n)$	-2	-1	2

3. Find and sketch the linear and circular convolutions of the eight point sequences x(n) and h(n) given below.

n	0	1	2	3	4	5	6	7
x(n)	1	0.5	0	0	0	0	0	0.5

n	0	1	2	3	4	5	6	7
h(n)	1	1	0	0	0	0	0	1

4. Give two alternative approaches to estimation of power spectral density. Sketch how these could be implemented.
5. What is a window in the context of spectral analysis? Why are windows used in spectrum analysis and what is spectral leakage? Are there any disadvantages that arise from the use of windows?
6. What conditions are necessary for linear and circular convolution to be equivalent?
7. Why is the equivalence of circular and linear convolution of interest?
8. What are some applications of deconvolution?

9. A DFT processor is to be used to estimate the frequency spectrum of a real signal. The system must be able to process any signal having frequencies up to 250Hz. In addition, the interval between frequencies in the spectrum must be less than or equal to 0.5Hz.

(a) Determine the minimum record length, the maximum time between samples and the minimum number of points in a record

(b) Find the record length, the time between samples and the number of points in a record if thenumber of points is to be an integer power of two.

(c)

10. A speech signal is sampled at a rate of 20kHz (an appropriate anti aliasing filter has been used). A segment of length 1024 samples is selected and its DFT is computed.

(a) What is the time duration of the segment of speech?

(b) What is the frequency resolution (spacing in Hz) between DFT values?

(c) Suppose the 1024 point DFT of 512 rather than 1024 samples is computed. (the 512 samples are augmented with 512 zeros before the DFT is computed). How would this affect the answers to (a) and (b)?

(d) What would need to be done to the system to halve the frequency resolution found in part (b)?