

2009 Paper 8 Question 6

Digital Signal Processing

While reverse-engineering a radio receiver, you find in its firmware the following two discrete systems implemented:

$$y_n := x_n e^{j\pi n/2}$$
$$z_n := \sum_{k=-4000}^{4000} y_{n-k-4000} \times 10^{-3} \operatorname{sinc}(k/10^3) \times \left(0.54 - 0.46 \cos \left(2\pi \frac{k+4000}{8000} \right) \right)$$

The discrete sequence $\{x_n\}$ emerges from an analog-to-digital converter operating at sampling frequency $f_s = 240$ kHz, whose input is connected via a 100 kHz low-pass filter and linear amplifier directly to a radio antenna.

- (a) Explain the function of *both* discrete systems in the frequency domain and their main parameters (e.g. type of filter, cutoff frequency, type of window). [12 marks]
- (b) In approximately which frequency range will antenna signals substantially influence the resulting sequence $\{z_n\}$? [4 marks]
- (c) Will the subsequent application of the discrete system

$$b_n := z_{500n}$$

cause aliasing, and why?

[4 marks]