2007 Paper 8 Question 10

Digital Signal Processing

(*a*) The DAUB4 wavelet transform involves a pair of 4-point FIR filters.

(*i*) Explain the properties that these filters are designed to have and provide a system of equations that defines the two impulse responses accordingly. [8 marks]

(*ii*) Explain briefly how this filter pair is used in the wavelet transform. [4 marks]

(*b*) Consider a digital radio designed to receive all signals in the frequency range 90–105 MHz. Its antenna amplifier includes a bandpass filter that eliminates any signals outside this frequency range. The filtered antenna signal is directly fed into an analogue-to-digital converter, such that all subsequent demodulation steps can be performed in software.

(*i*) What is the lowest sampling frequency that can be used without risking loss of information due to aliasing? Explain briefly why. [5 marks]

(*ii*) If the resulting discrete sequence were turned into a continuous baseband signal through sinc interpolation, what relationship would there be between the spectra of the input and output signal? In particular, what would a 94 MHz sine-wave antenna signal be converted into? [3 marks]