COMPUTER SCIENCE TRIPOS Part II – 2012 – Paper 9

5 Digital Signal Processing (MGK)

(*a*) Make the following statements correct by changing one word or number. (Negating the sentence is not sufficient.)

(*i*) The z-transform of a sequence shows on the unit circle its discrete-time cosine transform. [1 mark]

(*ii*) Delaying a sequence by two samples corresponds in the z-domain to multiplication with z^2. [1 mark]

(*b*) Consider a causal digital IIR filter of order 2, operated at a sampling frequency of 48 kHz, where the impulse response $\{h_n\}$ has (for $n > 2$) the shape of a sine wave of frequency 8 kHz (amplitude and phase do not matter).

(*i*) Where in the z domain can you place two zeros and two poles to achieve such an impulse response $\{h_n\}$ in the time domain? [4 marks]

(*ii*) Write down the z transform of $\{h_n\}$ as a rational function (with those zeros and poles). [6 marks]

(*iii*) Provide the constant-coefficient difference equation that describes the time-domain behaviour of that filter. [4 marks]

(*iv*) How can you use such a filter design to digitally generate an 8 kHz sinewave sampled at 48 kHz with very little computational effort? [4 marks]