

6 Digital Signal Processing (MGK)

Consider the discrete system

$$y_n = \sum_{i=0}^{\infty} x_{n-2i} \cdot \left(-\frac{1}{2}\right)^i$$

- (a) Write down the first 8 samples of the impulse response of this filter. [2 marks]
- (b) Provide the finite-difference equation of an equivalent recursive filter that can be implemented with not more than two delay elements. [4 marks]
- (c) What is the  $z$ -transform  $H(z)$  of the impulse response of this filter? [4 marks]
- (d) Where are the zeros and poles of  $H(z)$ ? [6 marks]
- (e) We now operate this discrete system at sampling frequency  $f_s = 1$  MHz and feed it with input  $x_n = \cos(2\pi f n / f_s)$ . For which  $f$  (with  $0 \leq f \leq f_s/2$ ) will the peak amplitude of the output sequence  $\{y_n\}$  be largest, and how large will it be? [4 marks]