

A *resonance filter* is a specific second-order digital system designed to attenuate all frequencies except at and around a given center frequency. The transfer function of a resonance filter is:

$$H(z) = \frac{(1-r)(1-rz^{-2})}{1-2r\cos(\omega_c T)z^{-1}+r^2z^{-2}}, \quad (2)$$

where $\omega_c = 2\pi f_c$, where f_c is the center frequency (in Hz), and r is a parameter that controls the resonance bandwidth.

- (a) Show that, for any given resonance frequency ω_c and any value of the parameter r , the amplitude response of the filter equals unity at $\omega = \omega_c$, i.e. $|H(\omega_c)| = 1$.
- (b) Give the difference equation of this filter.
- (c) Sketch a signal diagram for this filter.