Notch Filter Exercise

A second-order recursive notch filter is illustrated in Fig. 1. The filter has a null at the frequency 0.05 cycles/sample (equivalently, 0.1π radians/sample). The poles have a modulus of 0.9. The filter is normalized so the dc gain is unity, as evident in the plot. But the gain on the high-frequency side exceeds unity, reaching 1.11.

Task: Design a third-order recursive notch filter with a null at the same frequency. The new filter should have a gain of unity at both $f = 0$ and $f = 0.5$ cycles/sample. The difference equation should have real-valued coefficients. There is more than one correct solution. The frequency response magnitude of one solution is illustrated in Fig. 2.

To submit: Mathematical derivation, difference equation coefficients, pole-zero diagram, frequency response magnitude, and Matlab code.

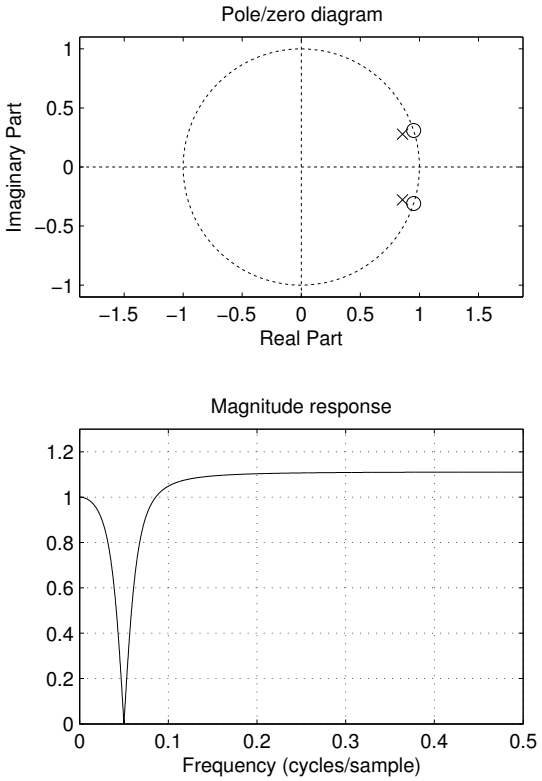

Figure 1: Second-order recursive notch filter with notch at 0.05 cycles/sample.

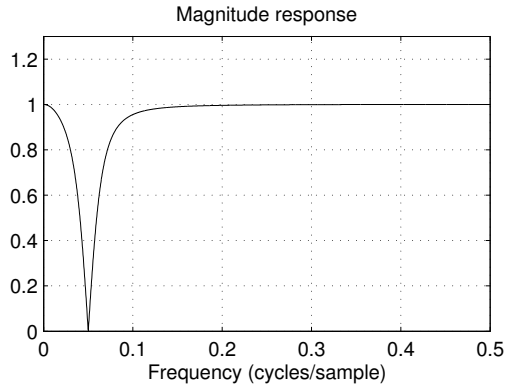

Figure 2: Third-order recursive notch filter with unity gain on both sides of the null.