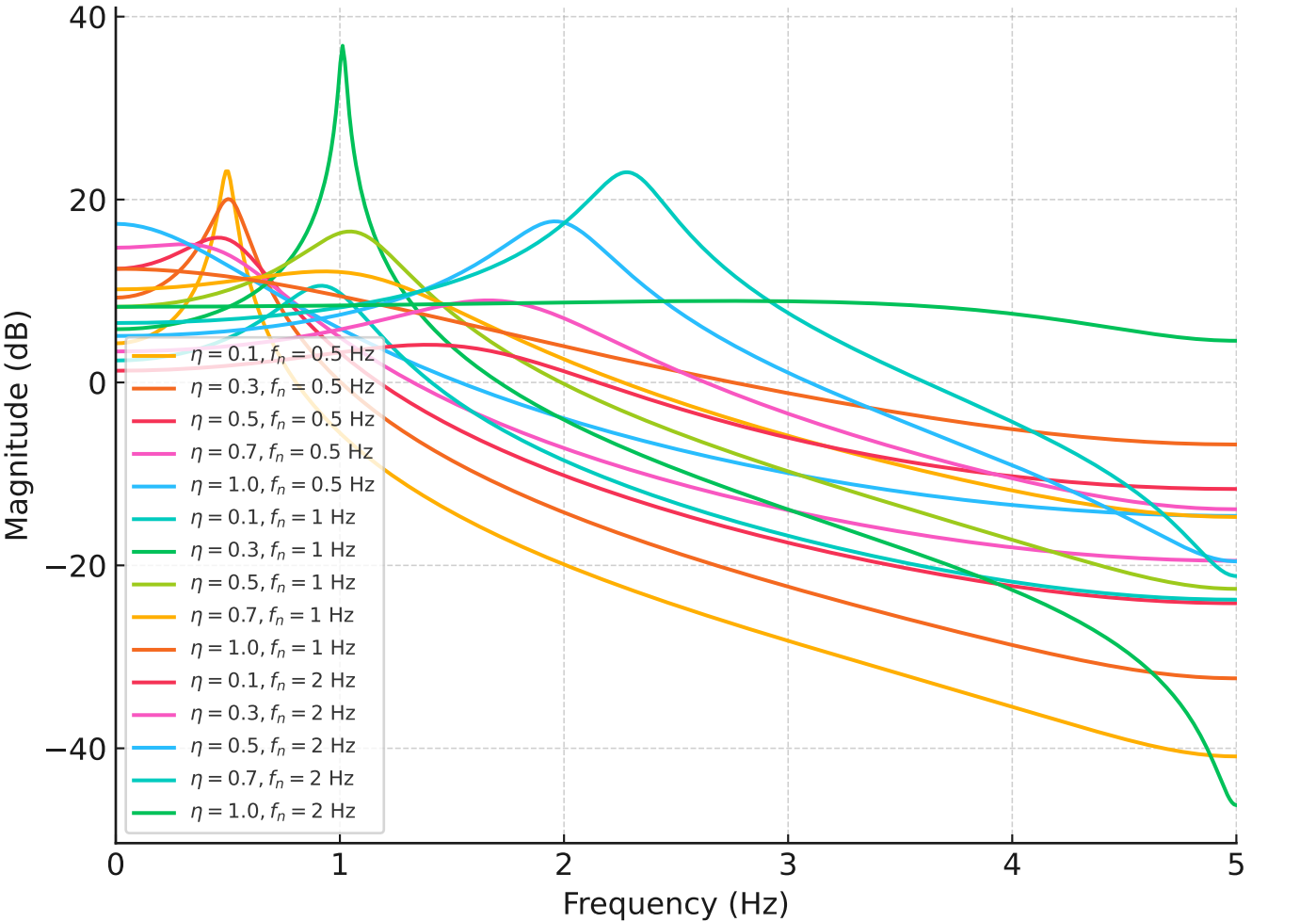
Frequency Response of the Digital PLL Transfer Function $H(Z)$
Magnitude (dB)
Frequency (Hz)
40
20
0
−20
−40
0
1
2
3
4
5
$\eta = 0.1, f_n = 0.5$ Hz
$\eta = 0.3, f_n = 0.5$ Hz
$\eta = 0.5, f_n = 0.5$ Hz
$\eta = 0.7, f_n = 0.5$ Hz
$\eta = 1.0, f_n = 0.5$ Hz
$\eta = 0.1, f_n = 1$ Hz
$\eta = 0.3, f_n = 1$ Hz
$\eta = 0.5, f_n = 1$ Hz
$\eta = 0.7, f_n = 1$ Hz
$\eta = 1.0, f_n = 1$ Hz
$\eta = 0.1, f_n = 2$ Hz
$\eta = 0.3, f_n = 2$ Hz
$\eta = 0.5, f_n = 2$ Hz
$\eta = 0.7, f_n = 2$ Hz
$\eta = 1.0, f_n = 2$ Hz

Discussion and Missing Insights from the Paper:

1. The variable ω_n represents the natural frequency in the Laplace doma
   - It is related to the system's resonance and stability.

2. When transitioning to the discrete domain (Z-transform), the correspon
   - Ω = ω_n * T (Digital angular frequency in radians/sample).
   - This scales the frequency response based on the sampling rate.

3. The paper does not explicitly state that the frequency response in discr
   onto the unit circle using the transformation:
   - Z = e^{jΩ}, where Ω is the discrete-time angular frequency.

4. In digital systems, frequencies are normalized:
   - Digital frequency: f_d = (ω_n / 2π) * fs.
   - This ensures the response is within the Nyquist range.

5. The paper assumes T is small (high sampling rate), but does not empha
   - How the discrete-time natural frequency relates to the Nyquist frequer
   - The importance of interpreting system response on the unit circle.

These points provide a more complete understanding of how the analog P
its discrete-time (DPLL) implementation.