CARLETON UNIVERSITY
DEPARTMENT OF ELECTRONICS

ELEC 5606

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Assignment #l

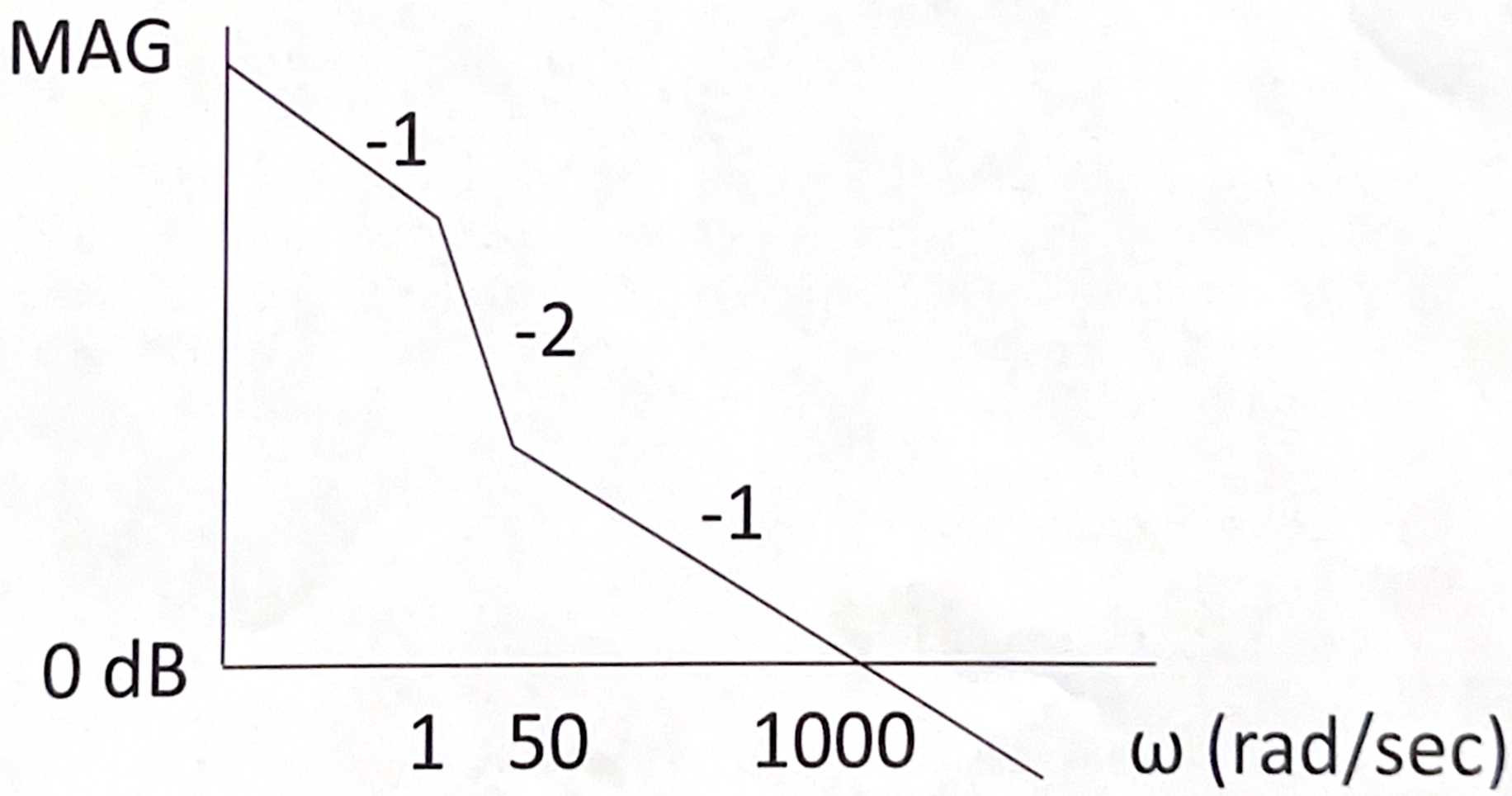
Due: October 9, 2025

1. We require a 50 MHz first order Phase Locked Loop with a synchronization range of +/- 5 KHz. We have a sinusoidal phase detector with characteristic $K_1 = 2$ V/rad, and require a maximum loop phase error of 0.2 rad.

   - Find the required VCO sensitivity
   - Find the VCO frequency stability.

2. The Bode Plot for a PLL is shown in the Figure.

   - What type of loop is this?
   - What are the loop's τ_1, τ_2, and K?
   - What are the loop's ω_n and ξ?
   - What is the phase safety margin?



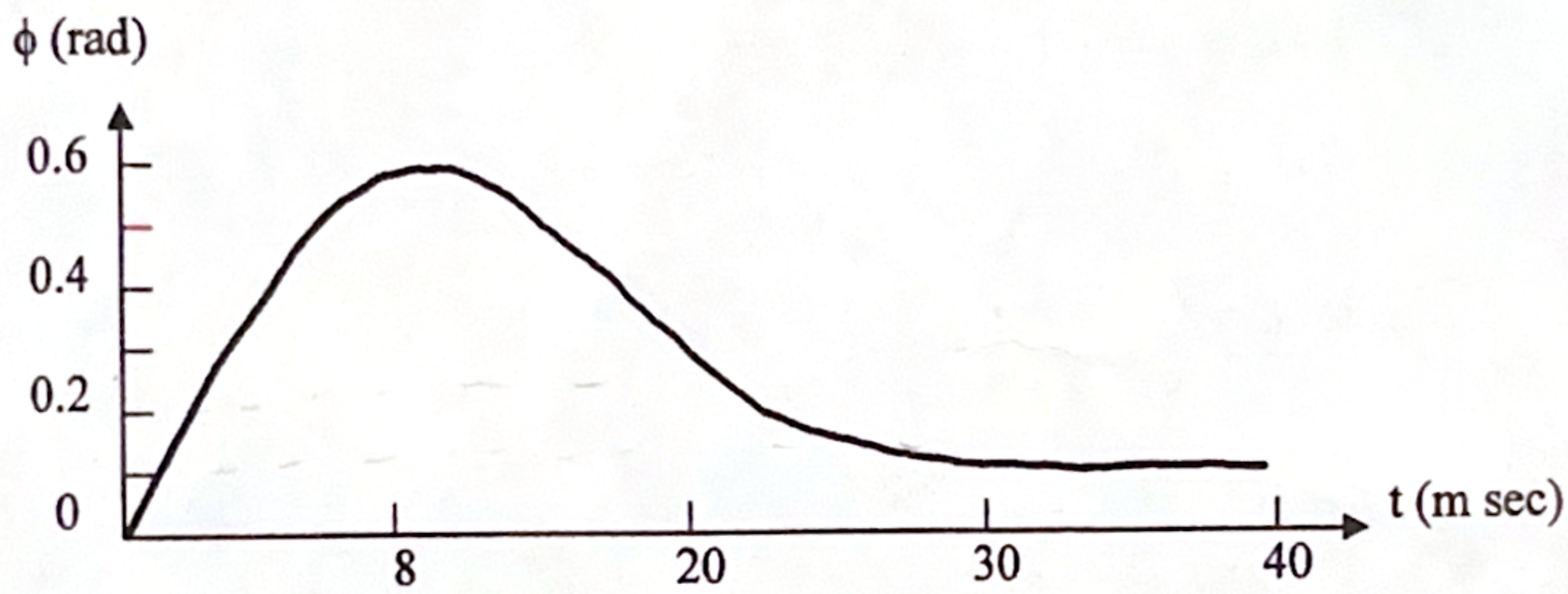
3. The open loop transfer function of a PLL utilizing a LPF with phase lead correction is given by

$$G(j\omega) = K\,(1 + j\omega\tau_2) / [\,j\omega\,(1 + j\omega\tau_1)]$$

- Using the analytic root locus method, plot the LHS (Left Hand Side) of the real part of the Denominator of the Closed Loop Transfer Function (when it is forced to be equal to $0 + j0$) versus σ.

- Explain why the loop is unconditionally stable.

4. When excited by a frequency step of 200 rad/sec, the phase response for a second order loop incorporating a low pass filter with phase lead correction, and having a damping constant of 1 is shown in the diagram.



- What is the loop gain K and natural frequency ω_n?

5. We have a second order loop with an integrator with phase lead correction. The input signal to the loop is a 4 MHz frequency modulated signal with a frequency deviation of 500 Hz. As the modulating frequency Ω is changed we note that the maximum phase error $\Delta\phi$ is 0.35 rad and occurs for a modulating frequency $\Omega = 1$ KHz.

- What is the damping constant ξ

- What is the natural frequency ω_n

- For what frequency deviation does the maximum phase error $\Delta\phi$ remain below 0.2 rad.