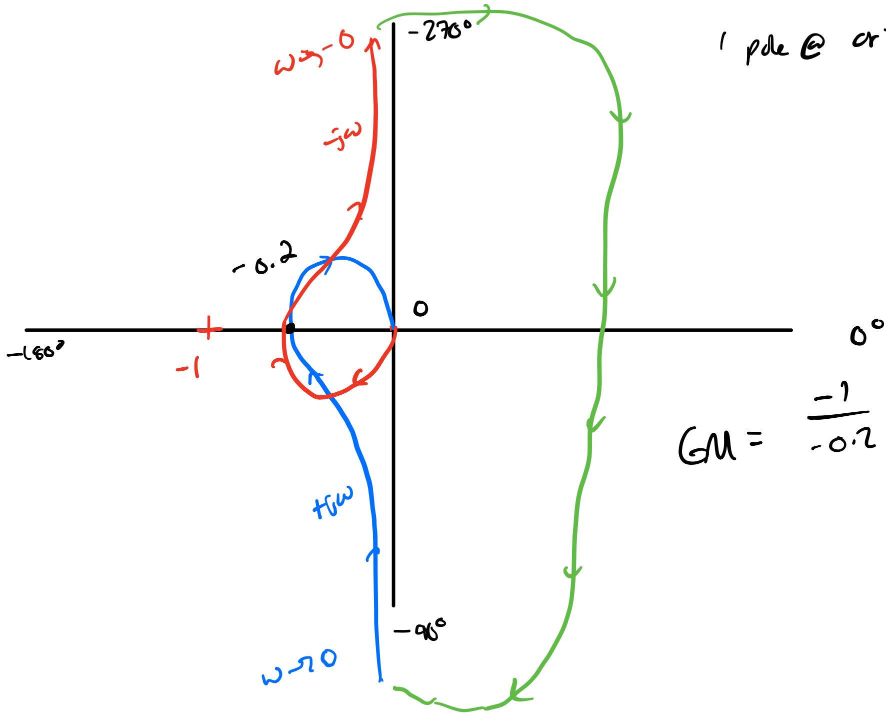
HW6

$$G(s) = \frac{5000}{(10s^2+5)(s+100)}$$

-90° $\quad$ -180° $\quad$ -270

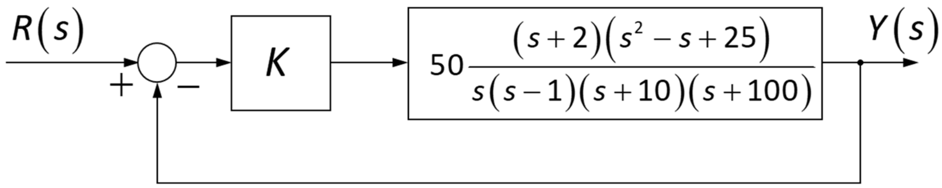
$\uparrow 10^5$ $\quad$ 10^0 $\quad$ $10^{-9}\downarrow$ asympt.



1 pole @ origin → −180°

$$GM = \frac{-1}{-0.2} \approx 5$$

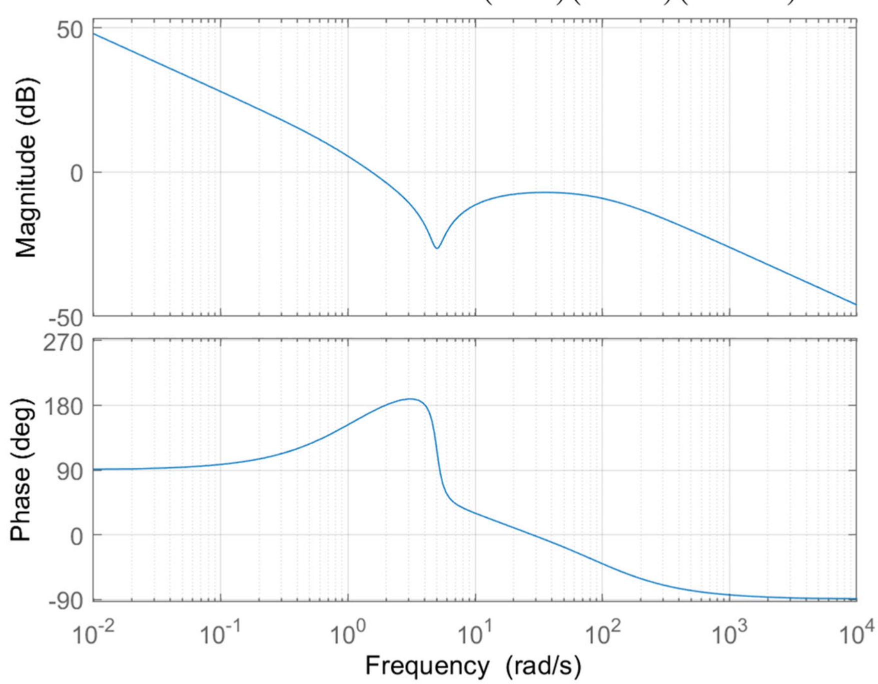
Problem #2: A partially completed Nyquist plot for the closed-loop system shown below (when K = 1), constructed using the open-loop frequency response (see below), is shown in the figure on the next page. Note, the partially completed Nyquist plot is NOT drawn to scale.

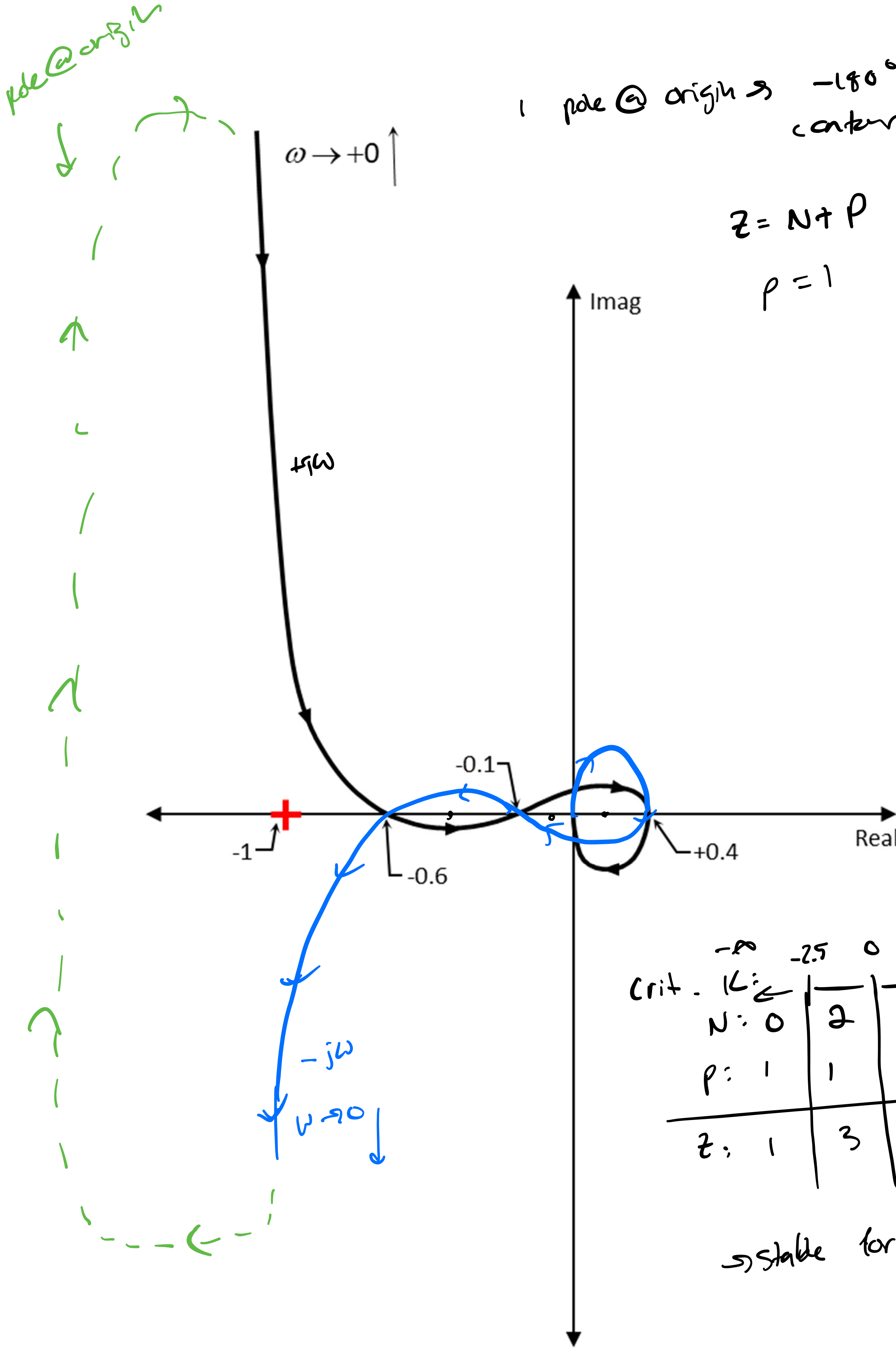


Complete the Nyquist plot sketch (i.e. overlay your sketch on top of the partially completed plot). In your solution make sure you do the following:

(1) Identify the portion of the Nyquist plot that is based on the contour along the $+j\omega$-axis and $-j\omega$-axis. Identify any part of the Nyquist plot that is due to poles at the origin. Make sure you annotate the plot to indicate its direction as you evaluate the clockwise contour around the complete right-half plane (of the complex plane) You will not be able to draw your sketch to scale.
(2) Identify the number of -1 encirclements and state whether the system is stable.
(3) Determine the range of gains, K, for which the system is stable and identify the number of unstable poles for gain values where the system is unstable. Consider both positive and negative gain.

Frequency response of: $50\dfrac{(s+2)(s^2-s+25)}{s(s-1)(s+10)(s+100)}$





1 pole @ origin → -180° contour

$Z = N + P$

$P = 1$

Crit. K:	$-\infty$ to -2.5	-2.5 to 0	0 to 1.7	1.7 to 10	10 to ∞
N:	0	2	1	-1	1
P:	1	1	1	1	1
Z:	1	3	2	0	2

→ stable for $K \in (1.7 : 10)$

~~Exam 2~~ P1:

$$\tau = \frac{-1}{S_{root}}$$

Exam 3 P2: $C(s) = \frac{1}{0.035s+1}$ $G(s) = \frac{1}{20s^2}$

1) PD for PM>50° → Design PM = 55° $\omega_c = 10$

$$\varphi_{des} = \angle G(j\omega_c)\,C(j\omega_c) + 55° = -\text{atan}\left(\frac{0.3}{1}\right) - \text{atan}\underbrace{\left(\frac{0}{-2000}\right)}_{-180°}$$

$$\rightarrow \varphi_{PD} = 71.7°$$

$$\angle (s + z_{pd})\Big|_{s=j\omega_c} = 71.7°$$

$$= \text{atan}\left(\frac{10}{z_{pd}}\right) = 71.7° \rightarrow z_{pd} = 3.31$$

Lag: $e_{ss} = 0.0076 \rightarrow \alpha = 8$

$$\left(\frac{s + z_{lag}}{s + p_{lag}}\right) \rightarrow \alpha = \frac{z}{p}$$

Set $z \ll \omega_c$

$= 1$

$\rightarrow p = \frac{1}{8} = 0.125$

PI: $\frac{(s + z_{PI})}{s} \rightarrow$ Set $z_{PI} \ll \omega_c$

$\rightarrow = 1$ ✓