

## PC2 - Describing Function Analysis

One considers the following system:

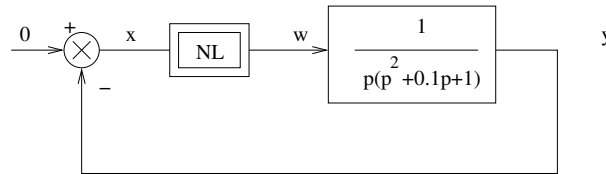


Figure 1: Nonlinear closed-loop

where the nonlinearity is a relay, first without hysteresis (figure II-a), and then with hysteresis (figure II-b).

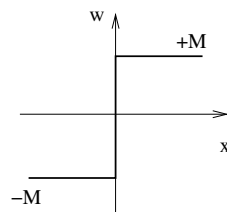


Figure II – a

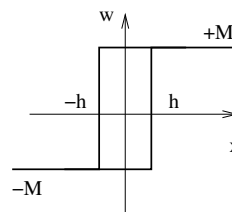


Figure II – b

Figure 2: Nonlinearity

1) In the first case (without hysteresis)

- Shows that a **limit-cycle** may appear,
- Is it stable or not?
- Compute its characteristics (pulsation, magnitude).

2) Now there is some hysteresis. Compute the new describing function  $N_1$  characterize the new critical locus  $-1/N_1$ . Then explain qualitatively (without any further computations) how the previous results are changed.

3) With the help of Figures 3, precise the above qualitative analysis according to  $h$ :

- How many limit-cycles can you detect finally?
- Discuss the stability of each.
- Precise their pulsations for  $h = 16M/\pi$ .
- What about the validity of the approximation (use Figure 4) ?

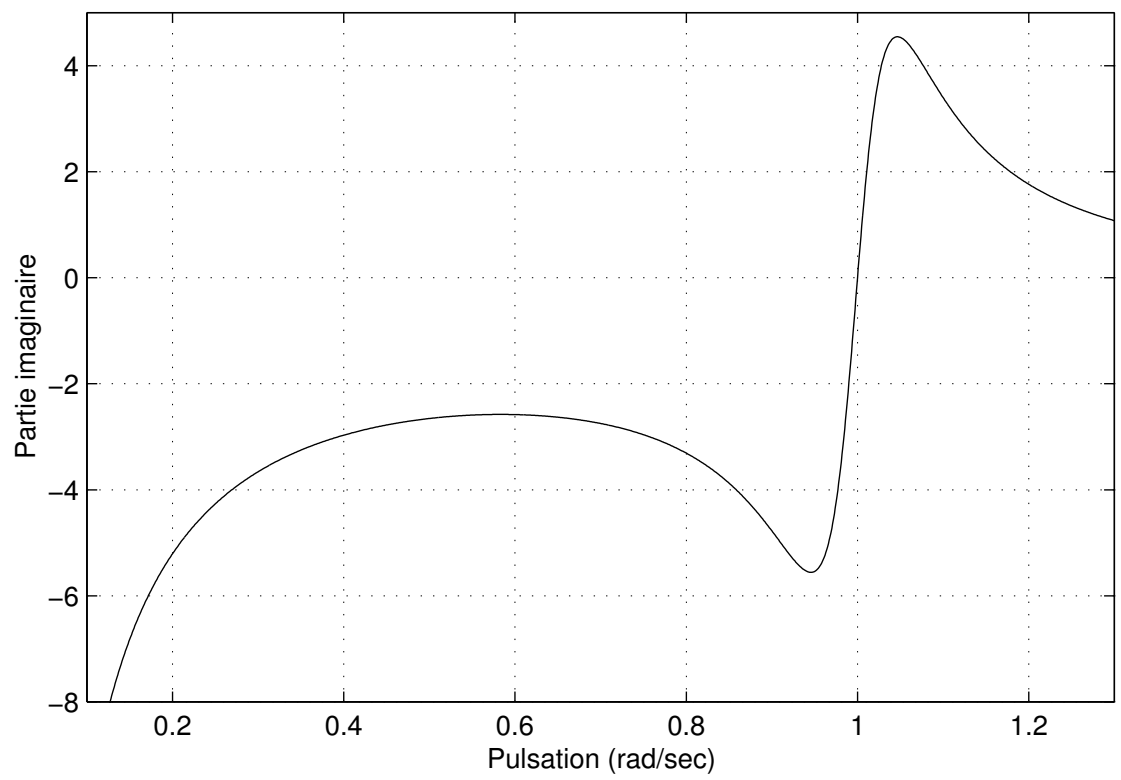
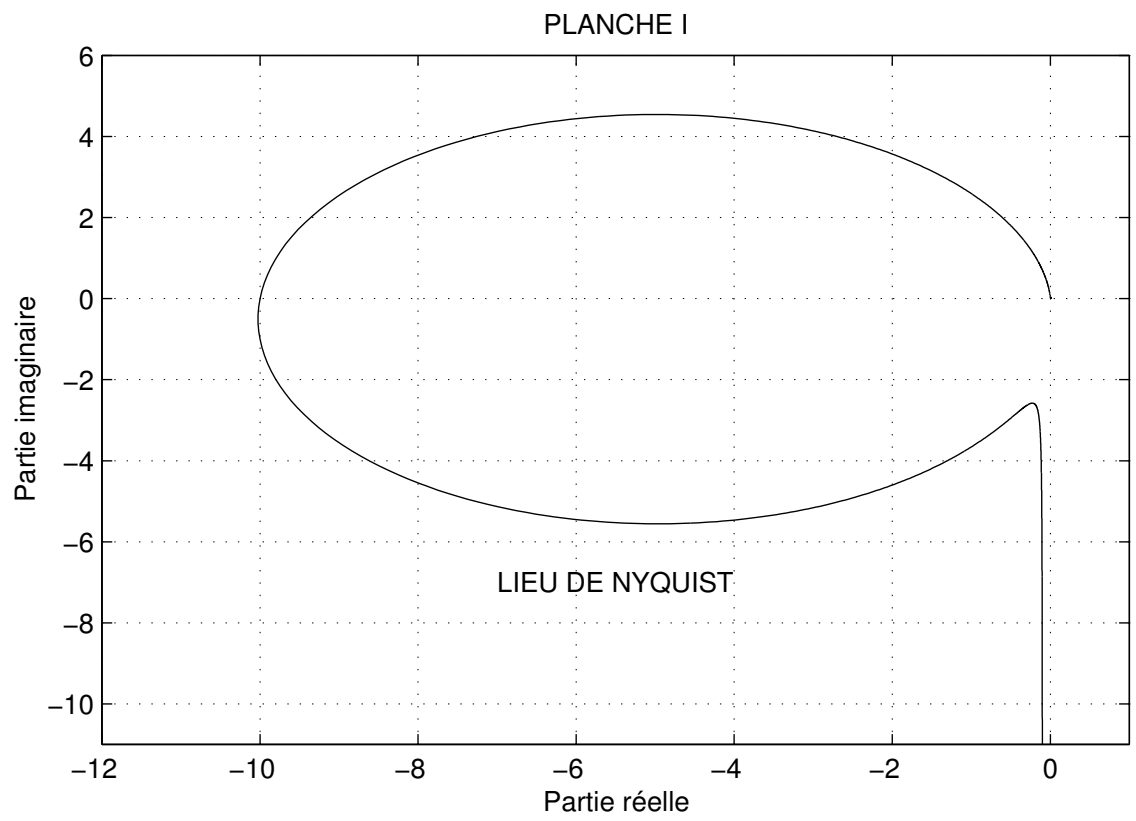


Figure 3: Nypuist plot

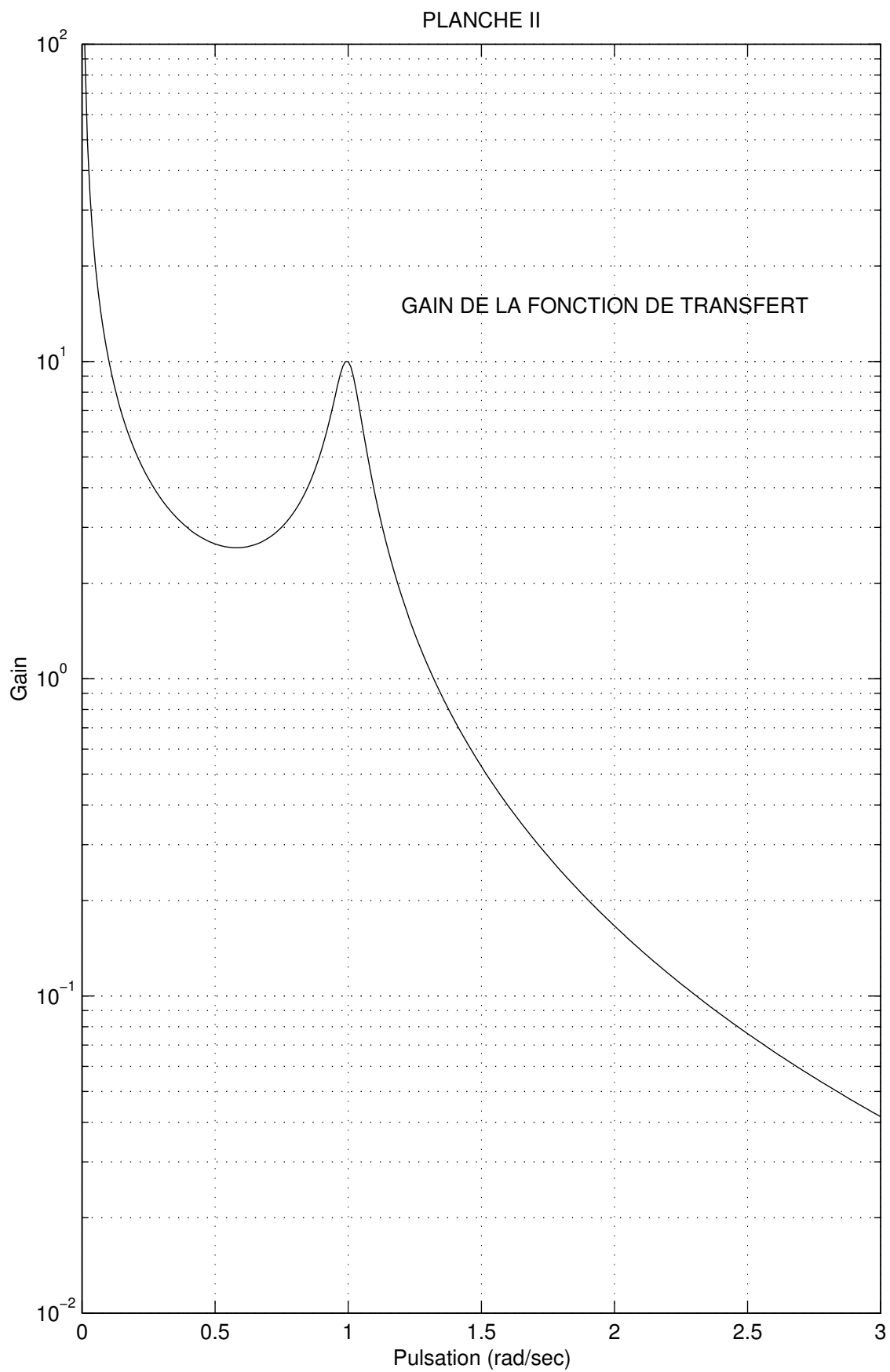


Figure 4: Gain