Diagrammi di Bode

1. Disegnare li diagramma di Bode della seguende funzione di trasferimento

$$H(s) = \frac{s^2 \cdot \left(1 + \frac{s}{10}\right)^2}{1 + \frac{s}{10} + \frac{s^2}{100}}$$

$K_b = 1$ Zero nullo $= s^2$ Polo complesso coniugato $= \left(1 + \frac{s}{10} + \frac{s^2}{100}\right)$

Zero reale $= \left(1 + \frac{s}{10}\right)^2$

Costante: Vale 1, quindi non influisce sulla funzione di trasferimento

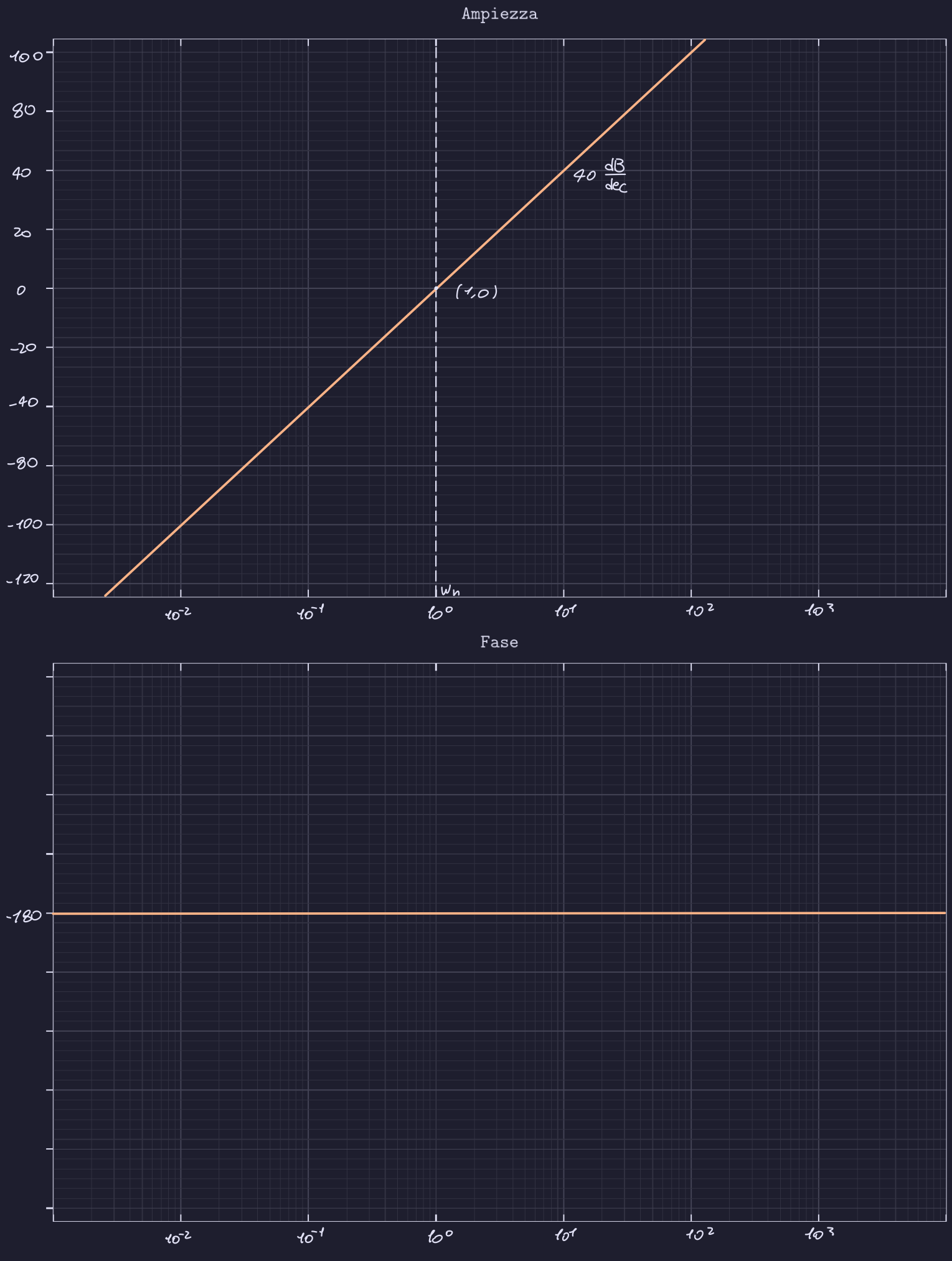
Zero nullo s^2

$A = 20 \cdot (-\mu) \frac{db}{dec} = -20 \cdot 2 = -40 \frac{db}{dec}$

$\Phi = -\mu \cdot 90 = -2 \cdot 90 = -180$

$w_n = 1$

Diagramma di Bode



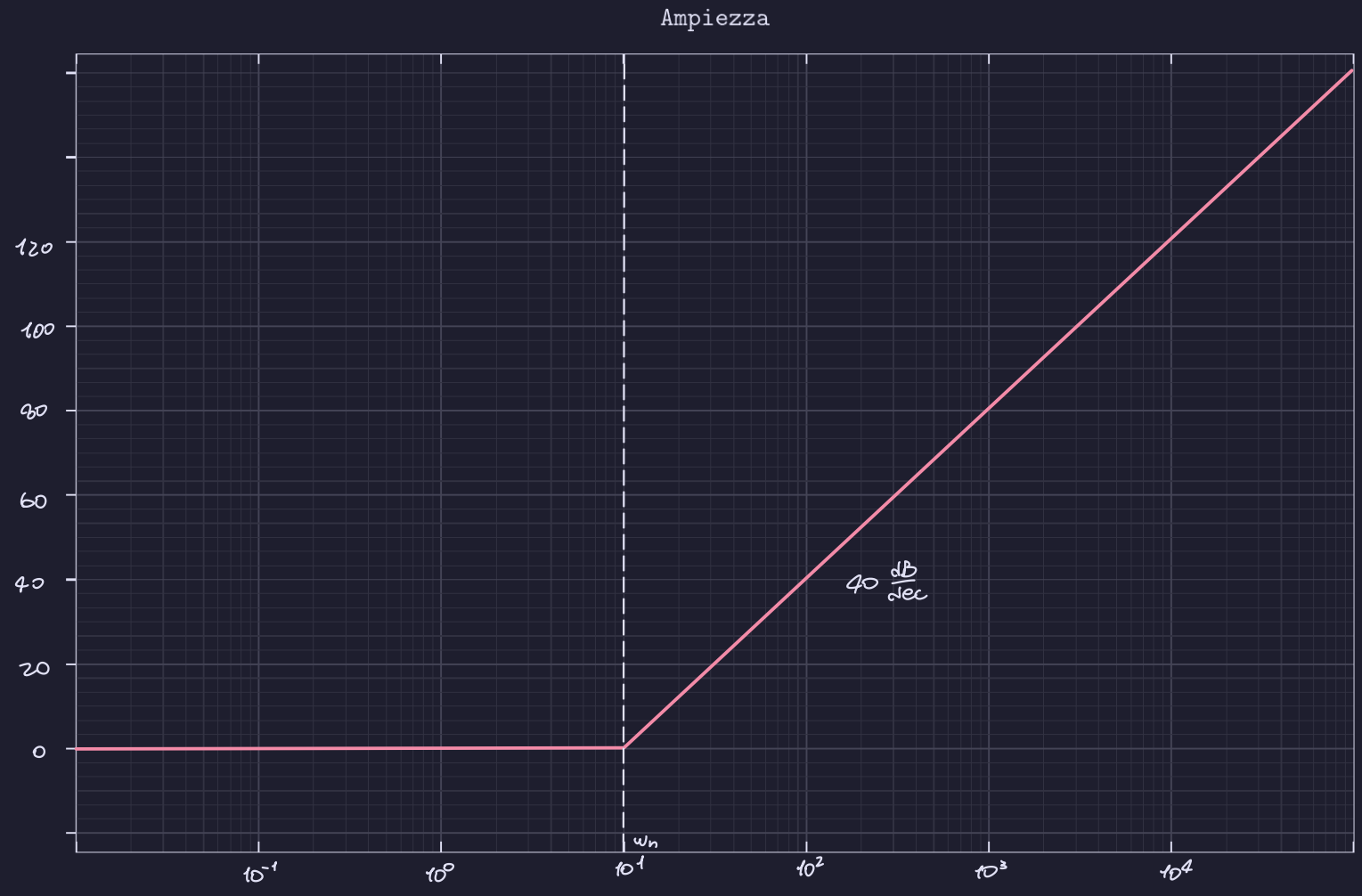
Zero reale $\left(1+\frac{s}{10}\right)^2$

$\mu = 2 \qquad \tau = \frac{1}{10} \qquad \omega_n = \frac{1}{\tau} = 10$

$$A = \begin{cases} 0 & \omega \le \omega_n \\ 20 \cdot \mu \ \frac{dB}{dec} & \omega > \omega_n \end{cases} = \begin{cases} 0 & \omega \le \omega_n \\ 40 \ \frac{dB}{dec} & \omega > \omega_n \end{cases}$$

$$\phi = \begin{cases} 0 & \omega \le \omega_n \\ \mu \cdot \text{segno}(\tau) \cdot 90^\circ & \omega > \omega_n \end{cases} = \begin{cases} 0 & \omega \le \omega_n \\ 180^\circ & \omega > \omega_n \end{cases}$$

Diagramma di Bode



Polo complesso coniugato $\left(1+\frac{s}{10}+\frac{s^2}{100}\right)$ $\left(1+2\xi\frac{s}{\omega_n}+\frac{s^2}{\omega_n^2}\right)$

$\frac{1}{\omega_n^2}=\frac{1}{100} \rightarrow \omega_n=\sqrt{100}=10$

$\frac{2\xi}{\omega_n}=\frac{1}{10} \rightarrow \xi=\frac{1}{10}\cdot\frac{\omega_n}{2}=\frac{\omega_n}{20}=\frac{10}{20}=\frac{1}{2}$

$\mu=-1$

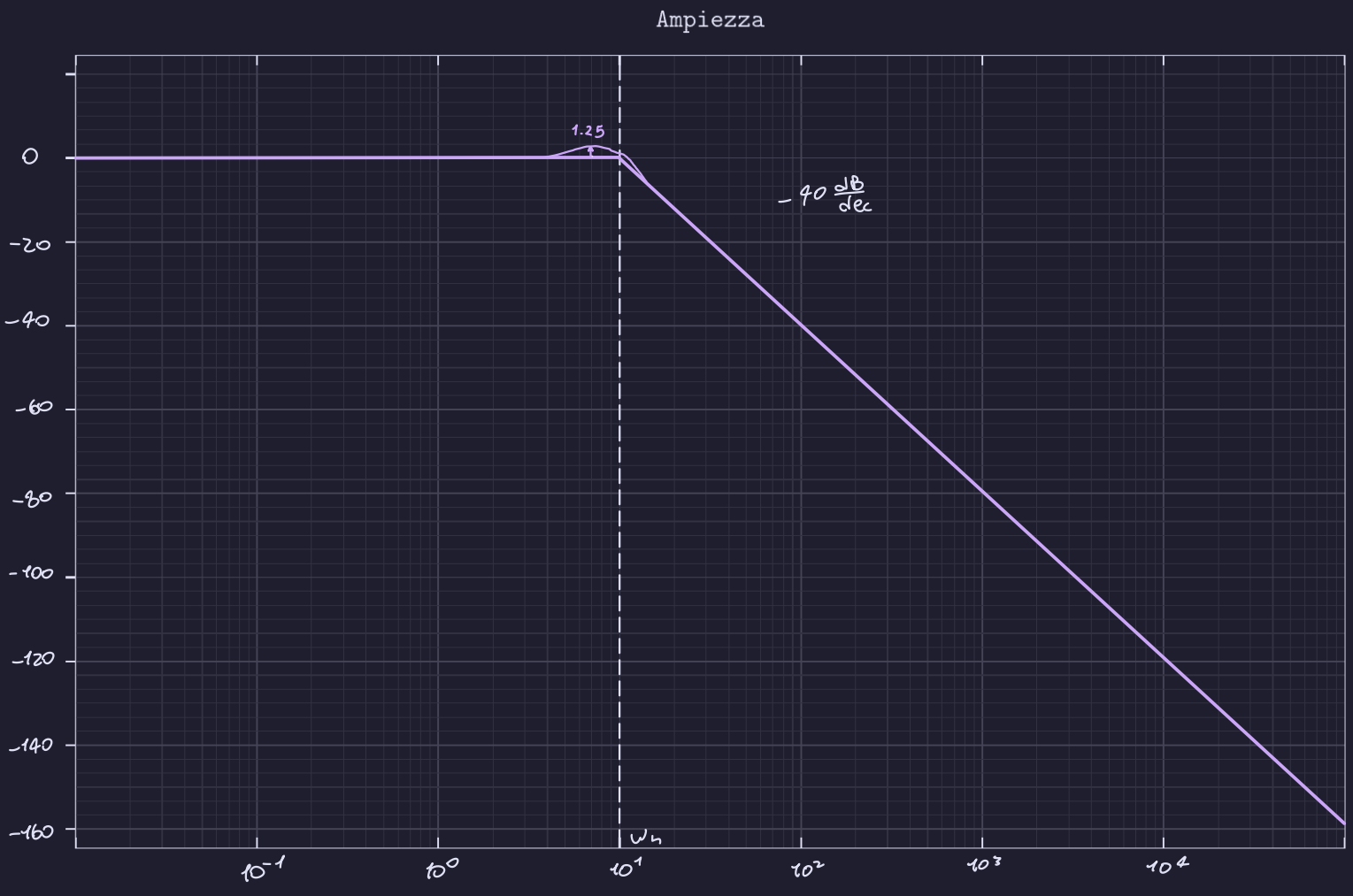
$\omega_r=\omega_n\cdot\sqrt{1-2\xi^2}=10\cdot\sqrt{1-\frac{1}{2}}=10\cdot\sqrt{\frac{1}{2}}\approx 7{,}07$

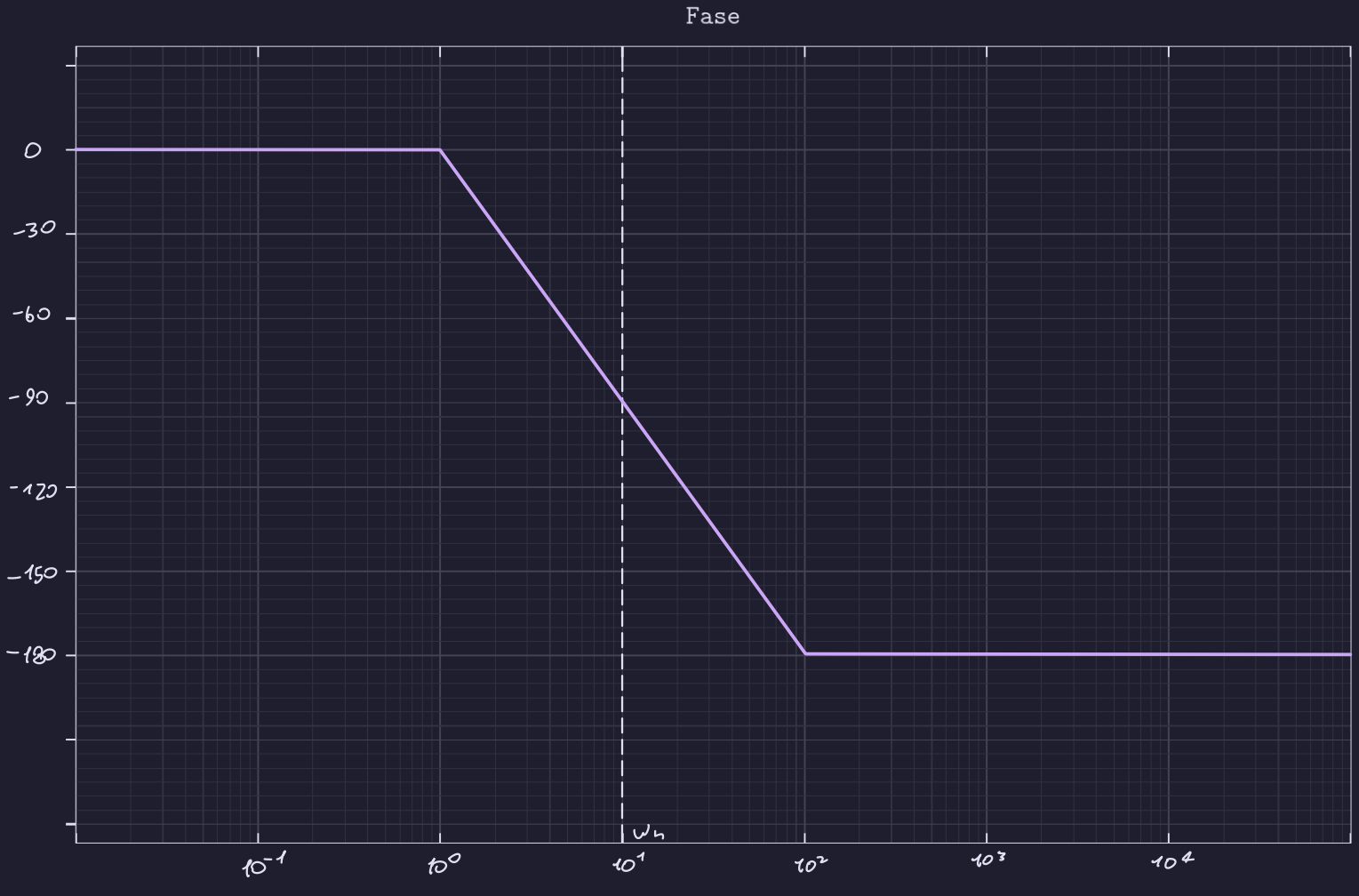
$M_r=20\mu\cdot\log_{10}\left(2\xi\cdot\sqrt{1-\xi^2}\right)=-20\log_{10}\left(\sqrt{1-\frac{1}{4}}\right)\approx 1.25$

$$A=\begin{cases}0 & \omega\leq\omega_n\\ 40\mu\ \frac{dB}{dec} & \omega>\omega_n\end{cases}=\begin{cases}0 & \omega\leq\omega_n\\ -40\ \frac{dB}{dec} & \omega>\omega_n\end{cases}$$

$$\Phi=\begin{cases}0 & \omega\leq\omega_n\\ \mu\cdot\text{segno}(\xi)\cdot 180 & \omega>\omega_n\end{cases}=\begin{cases}0 & \omega\leq\omega_n\\ -180 & \omega>\omega_n\end{cases}$$

Diagramma di Bode





Andamento ampiezza

	≤ 10	> 10
zero nullo	40	40
zero reale	0	40
polo complesso coniugato	0	-40
Totale	40	60

Andamento Fase

	$\leq 10^0$	10^1	$\geq 10^2$
zero nullo	-180	-180	-180
zero reale	0	90	180
polo complesso coniugato	0	-90	-180
Totale	-180	-180	-180

Diagramma di Bode Totale