

Disegnare i diagrammi di Bode del modulo e della fase della seguenti funzioni di trasferimento:

1. $G(S) = \frac{10^8}{(1+10^2 S)(S+10^3)}$ (Punti 1,5)

2. $G(S) = \frac{10^4 (S+10^4)(S+10^6)}{(S+10^3)(S+10^5)}$ (Punti 1,5)

3. $G(S) = \frac{(1+10S)(S+10^6)}{(S+10^3)(S+10^4)}$ (Punti 1,5)

4. $G(S) = \frac{10^5 (S+10^2)}{(1+10^3 S)(S+10^4)(1+10^5 S)}$ (Punti 1,5)

5. $G(S) = \frac{10^5 (S+10^8)}{(S+10^4)(S+10^6)}$ (Punti 1,5)

6. $G(S) = \frac{10^3 (S+10^3)(S+10^4)}{(S+10)(S+10^2)(S+10^5)}$ (Punti 1,5)

ES. N° 1

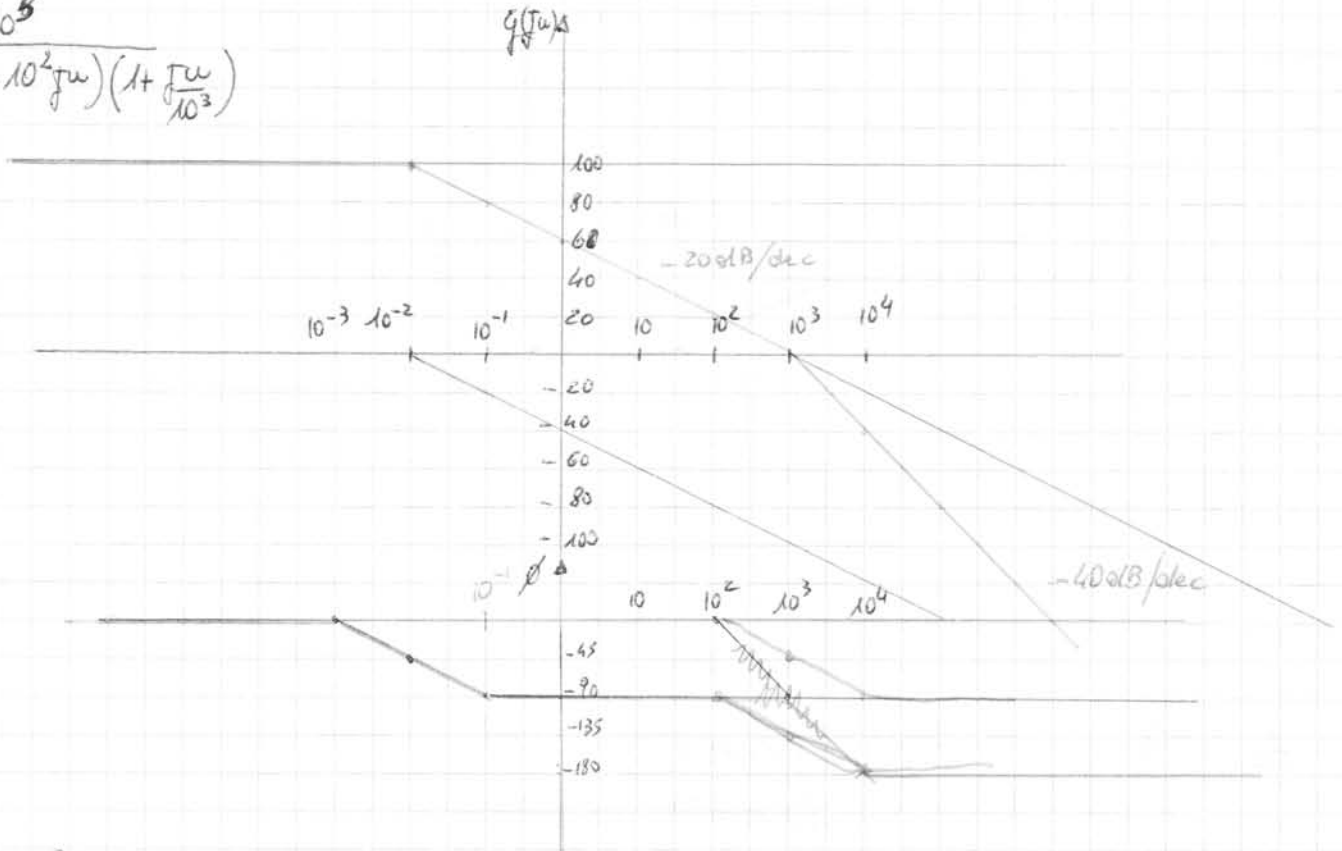
$$G(s) = \frac{10^8}{(1+10^2 s)(s+10^3)} = \frac{10^8}{(1+10^2 s) \cdot 10^3 \left(1 + \frac{s}{10^3}\right)}$$

$$p_1 = -10^3 \quad \omega_1 = 10^3 \text{ rad/s}$$

$$p_2 = -\frac{1}{10^2} = -10^{-2} \quad \omega_2 = 10^{-2} \text{ rad/s}$$

$$|const| = 20 \log 10^5 = 100 \text{ dB}$$

$$g(j\omega) = \frac{10^5}{(1+10^2 j\omega) \left(1 + \frac{j\omega}{10^3}\right)}$$



ES. N° 2

$$G(s) = \frac{10^4 (s+10^4)(s+10^6)}{(s+10^3)(s+10^5)}$$

$$G(s) = \frac{10^4 \cdot 10^4 \cdot 10^6 \left(1 + \frac{s}{10^4}\right) \left(1 + \frac{s}{10^6}\right)}{10^3 \cdot 10^5 \left(1 + \frac{s}{10^3}\right) \left(1 + \frac{s}{10^5}\right)}$$

$$z_1 = -10^4 \quad \omega_1 = 10^4 \text{ rad/s}$$

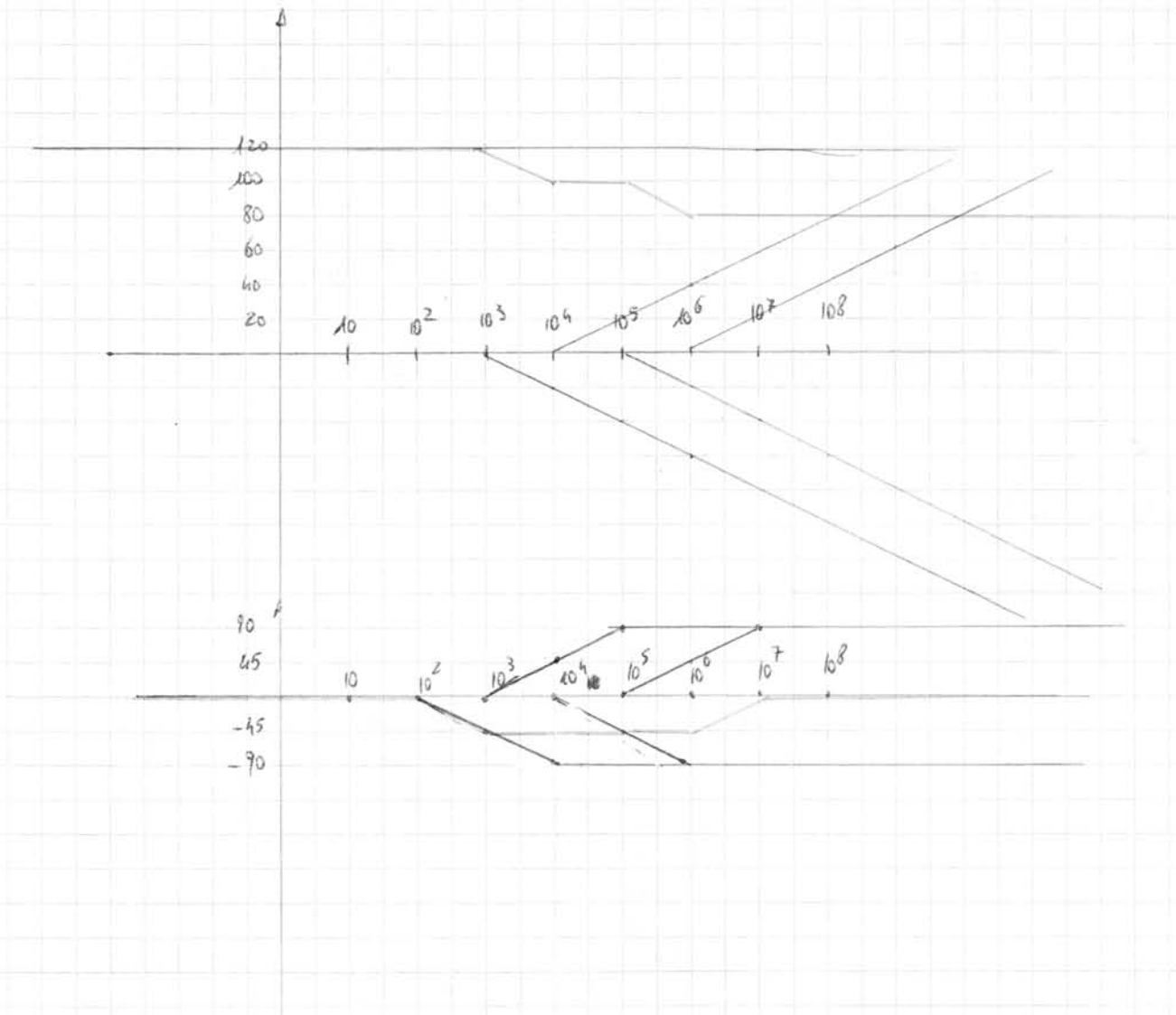
$$z_2 = -10^6 \quad \omega_2 = 10^6 \text{ rad/s}$$

$$p_1 = -10^3 \quad \omega_3 = 10^3 \text{ rad/s}$$

$$p_2 = -10^5 \quad \omega_4 = 10^5 \text{ rad/s}$$

$$g(j\omega) = \frac{10^6 \left(1 + \frac{j\omega}{10^4}\right) \left(1 + \frac{j\omega}{10^6}\right)}{\left(1 + \frac{j\omega}{10^3}\right) \left(1 + \frac{j\omega}{10^5}\right)}$$

$$|\cos \tau| = 20 \log 10^6 = 120 \text{ dB}$$



Ex. 10.3

$$G(s) = \frac{(1+10s)(s+10^6)}{(s+10^3)(s+10^4)}$$

$$G(s) = \frac{(1+10s) \cdot 10^6 (1 + \frac{s}{10^6})}{10^3 \cdot 10^4 (1 + \frac{s}{10^3}) (1 + \frac{s}{10^4})} = 10^{-1} \frac{(1+10s) (1 + \frac{s}{10^6})}{(\frac{1+s}{10^3}) (1 + \frac{s}{10^4})}$$

$$z_1 = -10^{-1}$$

$$\omega_1 = 10^{-1} \text{ rad/s}$$

$$z_2 = 10^6$$

$$\omega_2 = 10^6 \text{ rad/s}$$

$$p_1 = 10^3$$

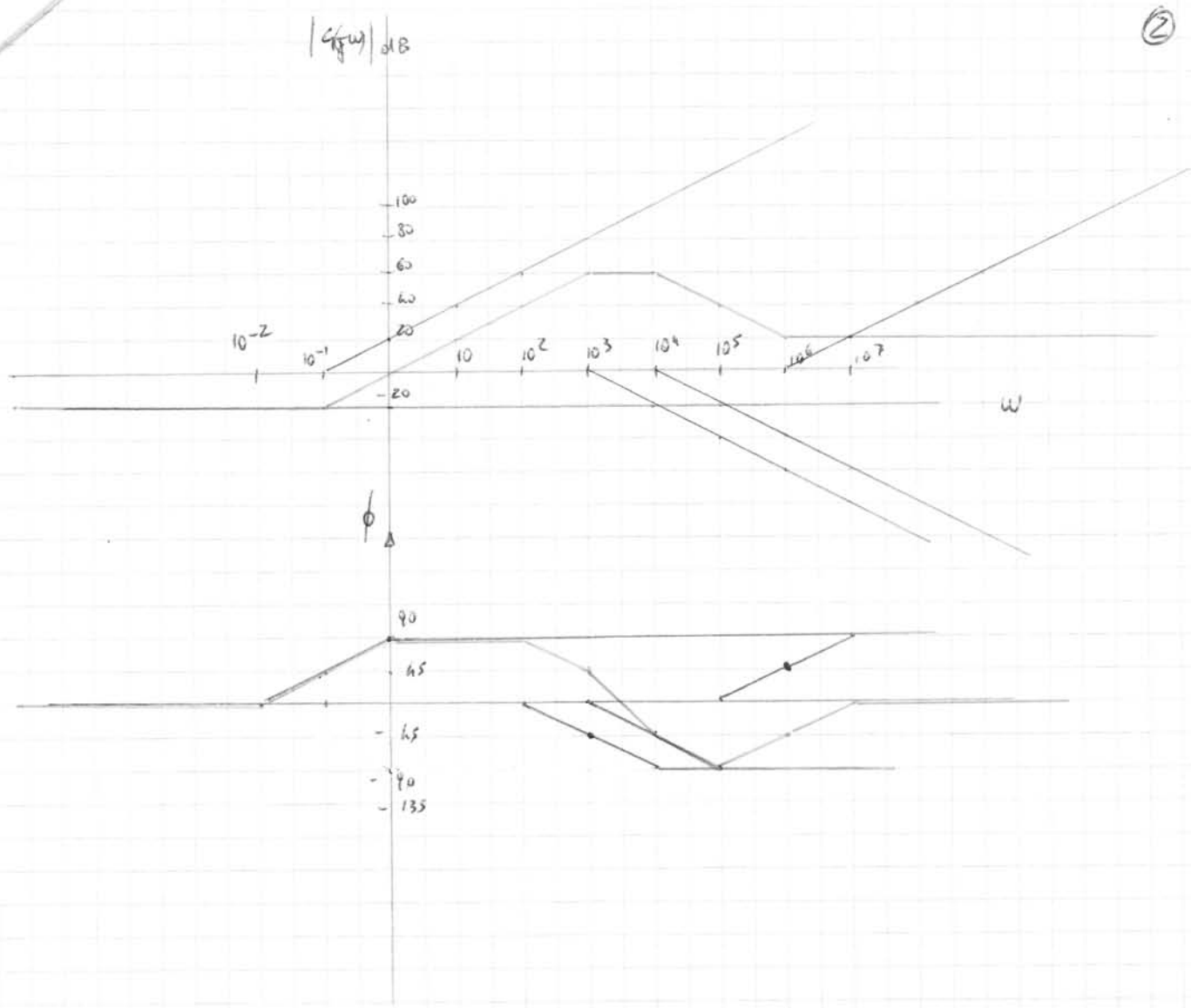
$$\omega_3 = 10^3 \text{ rad/s}$$

$$p_2 = 10^4$$

$$\omega_4 = 10^4 \text{ rad/s}$$

$$G(j\omega) = 10^{-1} \frac{(1+10j\omega) (1 + \frac{j\omega}{10^6})}{(\frac{1+j\omega}{10^3}) (1 + \frac{j\omega}{10^4})}$$

$$|\cos \tau| = +20 \log 10^{-1} = -20$$



Es. 4

$$G(s) = \frac{10^5 (s + 10^2)}{(1 + 10^3 s)(s + 10^4)(1 + 5 \cdot 10^5 s)}$$

$$= \frac{10^5 \cdot 10^2 \left(1 + \frac{s}{10^2}\right)}{(1 + 10^3 s) \cdot 10^4 \left(1 + \frac{s}{10^4}\right) (1 + 10^5 s)} = \frac{10^3 \left(1 + \frac{s}{10^2}\right)}{(1 + 10^3 s) \left(1 + \frac{s}{10^4}\right) (1 + 10^5 s)}$$

$z = -10^2$ $w_1 = +10^2 \text{ rad/s}$

$p_1 = -\frac{1}{10^3}$ $w_2 = 10^{-3} \text{ rad/s}$

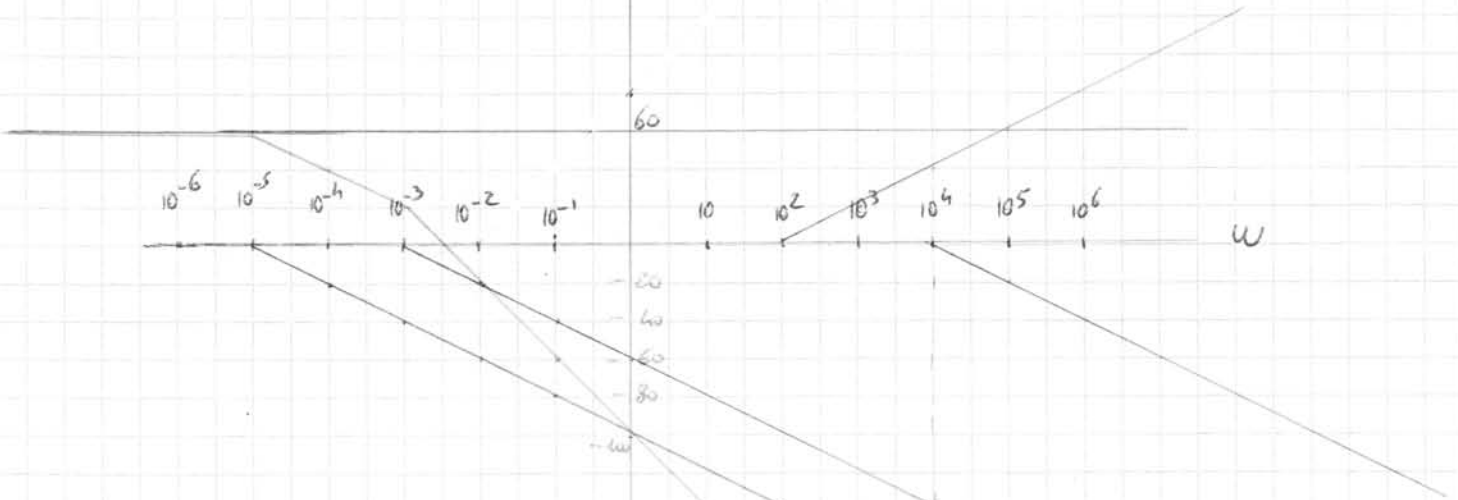
$p_2 = -10^4$ $w_3 = 10^4 \text{ rad/s}$

$p_3 = -\frac{1}{10^5}$ $w_4 = 10^{-5} \text{ rad/s}$

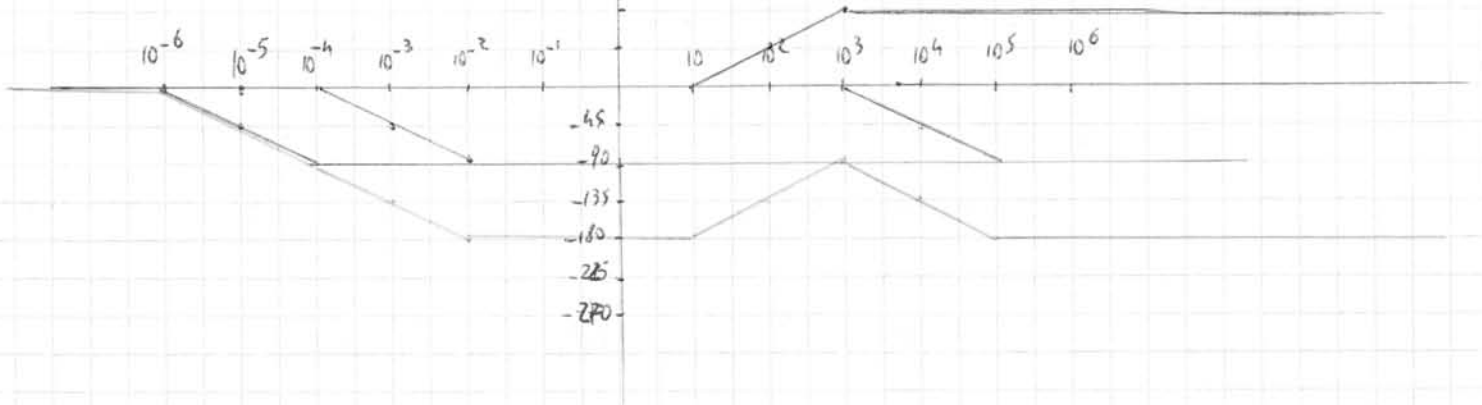
$|cont| = 20 \log 10^3$
 $= 60 \text{ dB}$

$$G(jw) = \frac{10^3 \left(1 + \frac{jw}{10^2}\right)}{(1 + 10^3 jw) \left(1 + \frac{jw}{10^4}\right) (1 + 10^5 jw)}$$

$|G(\omega)|$ dB



ϕ A



-100 dB/dec

$$G(s) = \frac{10^5 (s + 10^8)}{(s + 10^4)(s + 10^6)} = \frac{10^5 \cdot 10^8 \left(1 + \frac{s}{10^8}\right)}{10^4 \left(1 + \frac{s}{10^4}\right) \cdot 10^6 \left(1 + \frac{s}{10^6}\right)}$$

$$\downarrow$$

$$\frac{10^{13}}{10^{10}} \frac{\left(1 + \frac{s}{10^8}\right)}{\left(1 + \frac{s}{10^4}\right) \left(1 + \frac{s}{10^6}\right)}$$

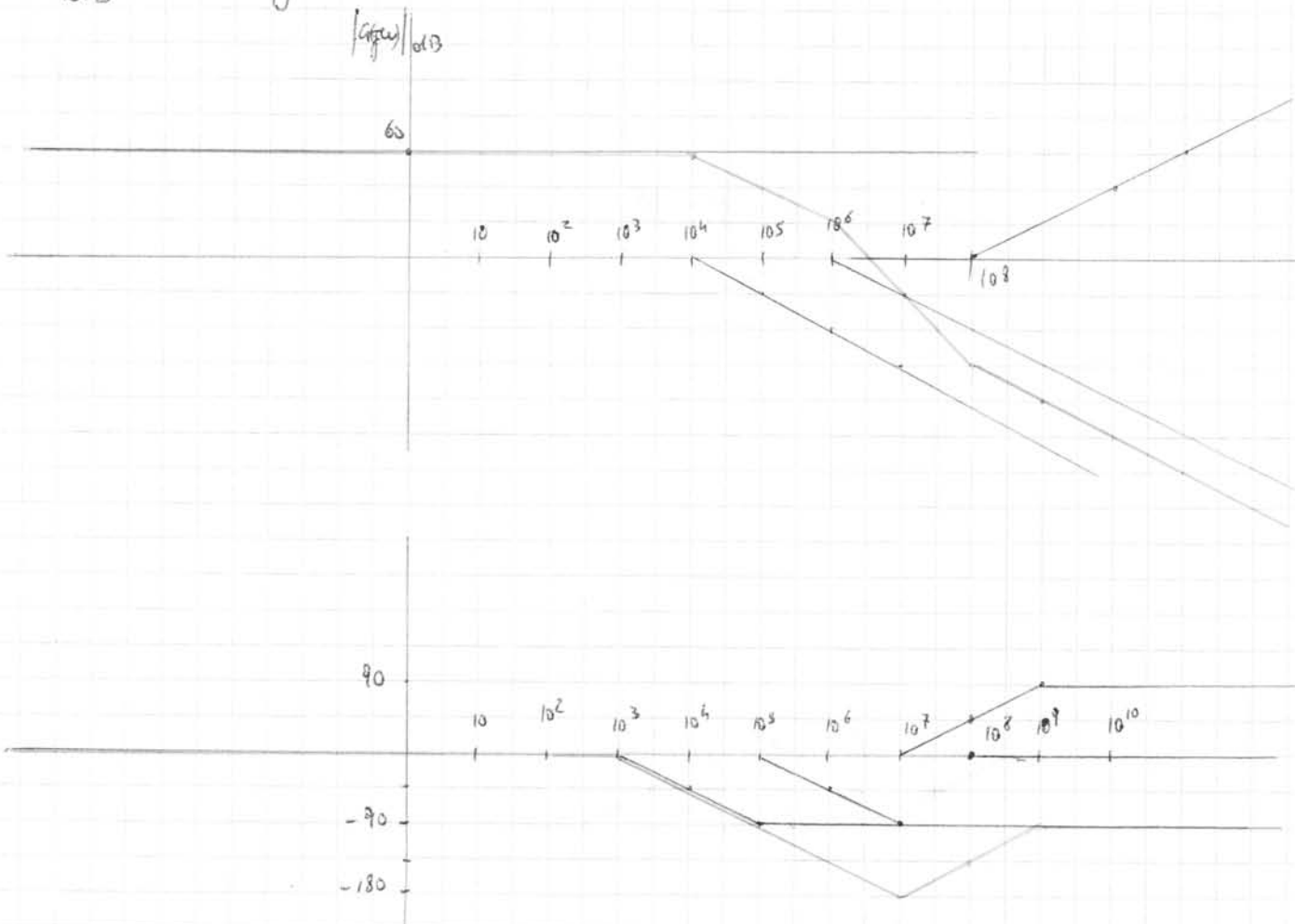
$Z = -10^8$ $\omega_1 = 10^8 \text{ rad/sec}$

$p_1 = -10^4$ $\omega_2 = 10^4 \text{ rad/sec}$

$p_2 = -10^6$ $\omega_3 = 10^6 \text{ rad/sec}$

$$G(j\omega) = \frac{10^3 \left(1 + \frac{j\omega}{10^8}\right)}{\left(1 + \frac{j\omega}{10^4}\right) \left(1 + \frac{j\omega}{10^6}\right)}$$

$$|G(j\omega)|_{dB} = 20 \log 10^3 = 60 \text{ dB}$$



SOLUZIONE ES. 6

$$G(s) = \frac{10^3 (s+10^3) (s+10^4)}{(s+10)(s+10^2)(s+10^5)}$$

$$= \frac{10^3 \cdot 10^3 \cdot 10^4 \left(1 + \frac{s}{10^3}\right) \left(1 + \frac{s}{10^4}\right)}{10 \cdot 10^2 \cdot 10^5 \left(1 + \frac{s}{10}\right) \left(1 + \frac{s}{10^2}\right) \left(1 + \frac{s}{10^5}\right)}$$

$$z_1 = -10^3$$

$$\omega_1 = 10^3 \text{ rad/s}$$

$$z_2 = -10^4$$

$$\omega_2 = 10^4 \text{ rad/s}$$

$$p_1 = -10$$

$$\omega_3 = 10 \text{ rad/s}$$

$$p_2 = -10^2$$

$$\omega_4 = 10^2 \text{ rad/s}$$

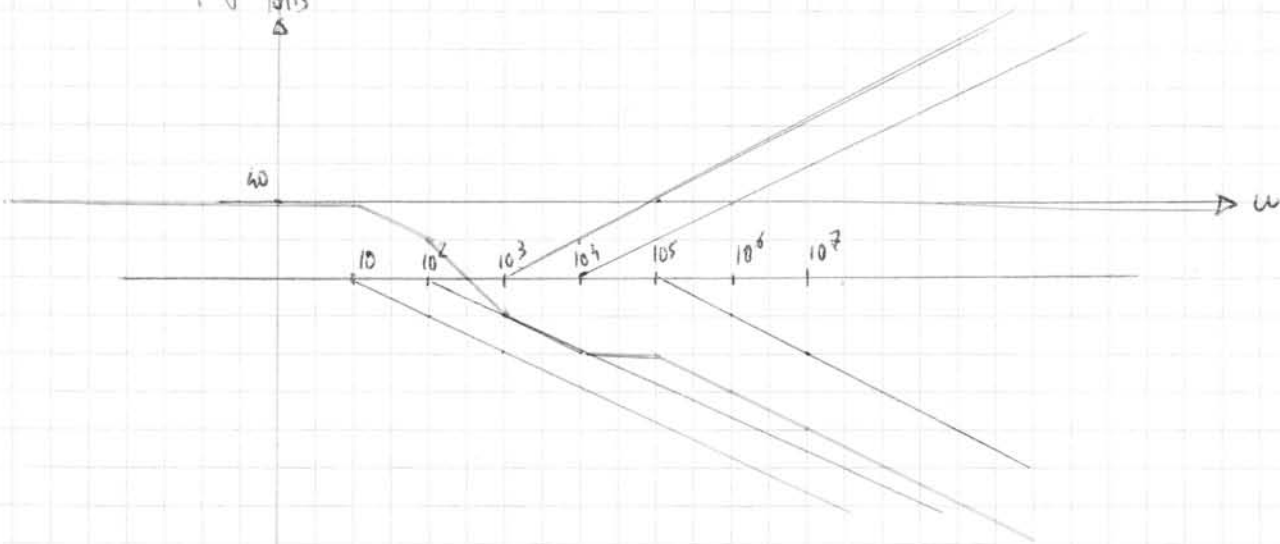
$$p_3 = -10^5$$

$$\omega_5 = 10^5 \text{ rad/s}$$

$$G(j\omega) = 10^2 \frac{\left(1 + \frac{j\omega}{10^3}\right) \left(1 + \frac{j\omega}{10^4}\right)}{\left(1 + \frac{j\omega}{10}\right) \left(1 + \frac{j\omega}{10^2}\right) \left(1 + \frac{j\omega}{10^5}\right)}$$

$$|G(j\omega)|_{dB} = 40 \text{ dB}$$

$|G(j\omega)|_{dB}$



ϕ

90

45

-90

