Problem 9.21 Determine the voltage transfer function $\mathbf{H}(\omega)$ corresponding to the Bode magnitude plot shown in **Fig. P9.21**. The phase of $\mathbf{H}(\omega)$ approaches 180° as ω approaches 0.

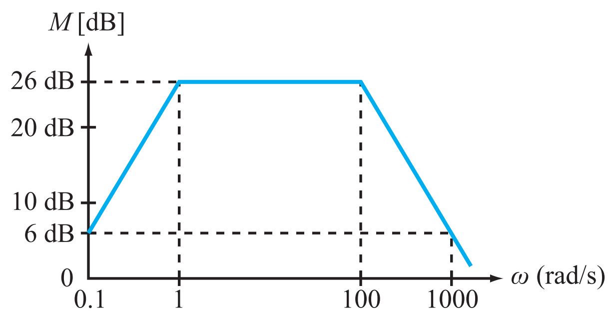

Figure P9.21: Bode magnitude diagram for Problem 9.21.

Solution: The transfer function consists of:

(1) A constant term K

(2) A zero @ origin of order 1 (slope is 20 dB/decade)

(3) A simple pole with $\omega_c = 1$ rad/s (slope reduces to 0 dB at $\omega_c = 1$ rad/s)

(4) A simple pole with $\omega_c = 100$ rad/s (slope changes to -20 dB/decade at $\omega_c = 100$ rad/s)

Hence,

$$\mathbf{H}(\omega) = \frac{(j)^N K\omega}{(1 + j\omega)(1 + j\omega/100)} .$$

At $\omega = 1$ rad/s, the only term that contributes to M [dB] is K. Thus,

$$26 \text{ dB} = 20 \log K,$$

or

$$K = 10^{26/20} = 20.$$

Since $\phi = 180°$ as $\omega \to 0$, it follows that $N = 2$.

The expression for $\mathbf{H}(\omega)$ is therefore given by

$$\mathbf{H}(\omega) = \frac{-20\omega}{(1 + j\omega)(1 + j\omega/100)}$$

$$= \frac{-2000\omega}{(1 + j\omega)(100 + j\omega)} .$$