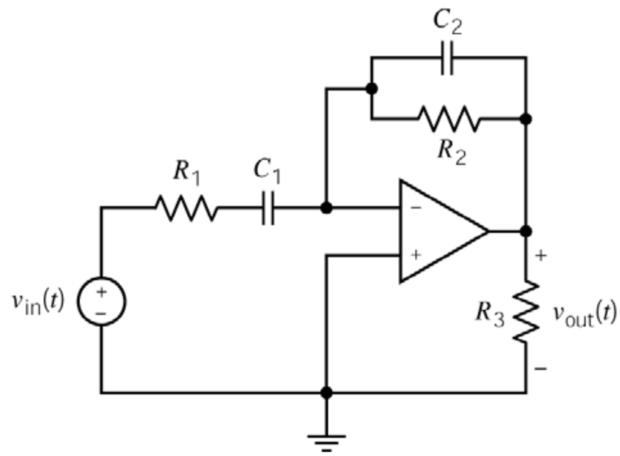
**Example:**

The input to this circuit is the voltage of the voltage source, $v_{\text{in}}(t)$. The output is the voltage across $R_3$, $v_{\text{out}}(t)$. The component values are

$$C_1 = C_2 = 0.1\ \mu\text{F},$$

$$R_1 = 5\ \text{k}\Omega,\ \ R_2 = 10\ \text{k}\Omega\ \text{ and }\ R_3 = 20\ \text{k}\Omega$$

Sketch the asymptotic magnitude Bode plot for the network function.




**Solution:**

The network function is:

$$\mathbf{H}(\omega) = -\frac{\dfrac{R_2}{1+j\omega C_2 R_2}}{R_1 + \dfrac{1}{j\omega C_1}} = -C_1 R_2 \frac{j\omega}{(1+j\omega R_1 C_1)(1+j\omega R_2 C_2)}$$

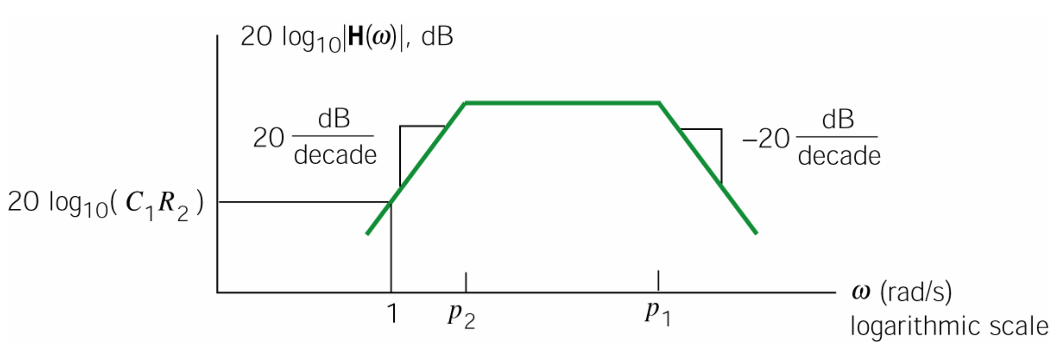
This network function has poles at

$$p_1 = \frac{1}{R_1 C_1} = 2000\,\text{rad/s}\ \text{ and }\ p_2 = \frac{1}{R_2 C_2} = 1000\,\text{rad/s}$$

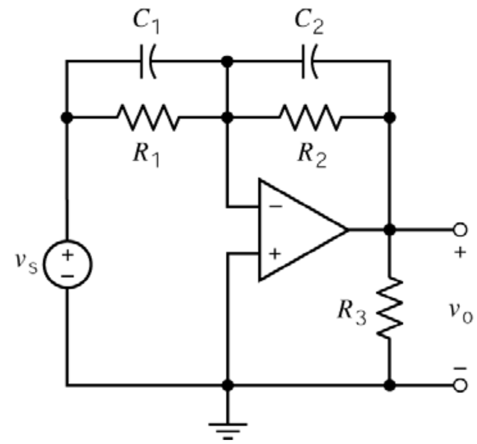
so

$$\mathbf{H}(\omega) \simeq \begin{cases} -(C_1 R_2)\,j\omega & \omega < p_2 \\ -(C_1 R_2)\dfrac{j\omega}{j\omega C_1 R_1} = -\dfrac{R_2}{R_1} = -2 & p_2 < \omega < p_1 \\ -(C_1 R_2)\dfrac{j\omega}{(j\omega C_1 R_1)(j\omega C_2 R_2)} = -\dfrac{1}{j\omega C_2 R_1} & \omega > p_1 \end{cases}$$

The corresponding asymptotic magnitude Bode plot is:



**Example:**



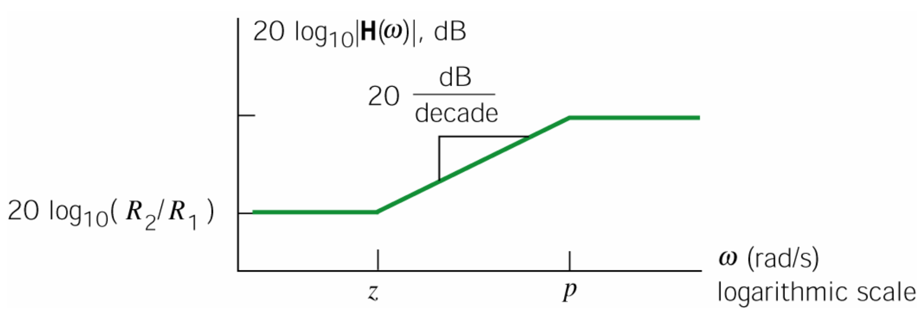

The input to this circuit is the voltage of the voltage source, $v_s(t)$. The output is the voltage across $R_3$, $v_o(t)$. Determine the network function, $\mathbf{H}(\omega)$ and sketch the asymptotic magnitude Bode plot.

**Solution:**
The network function is:

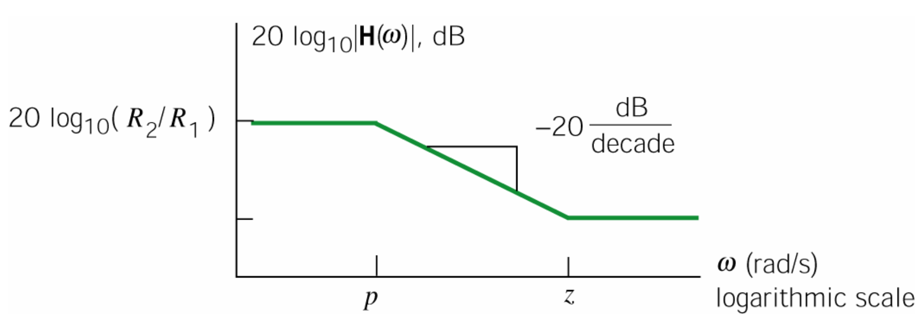
$$\mathbf{H}(\omega) = -\frac{\dfrac{R_2}{1+j\omega C_2 R_2}}{\dfrac{R_1}{1+j\omega C_1 R_1}} = -\frac{R_2(1+j\omega C_1 R_1)}{R_1(1+j\omega C_2 R_2)} = \frac{K\,(1+j\dfrac{\omega}{z})}{1+j\dfrac{\omega}{p}}$$

where $$K = -\frac{R_2}{R_1},\ z = \frac{1}{C_1 R_1} \text{ and } p = \frac{1}{C_2 R_2}$$

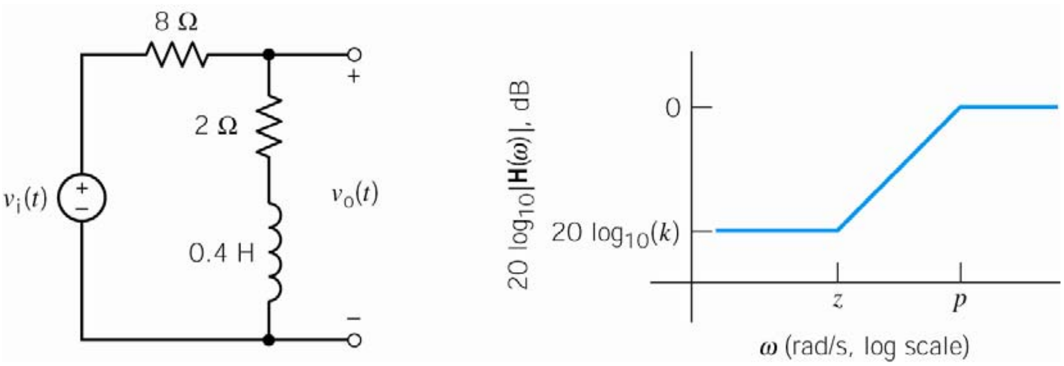
When $z < p$, the bode plot is



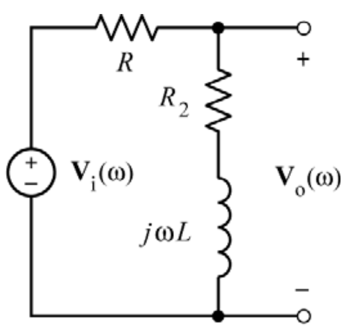

When $z > p$, the bode plot is



**Example:**
Consider this circuit and corresponding asymptotic magnitude Bode plot. The input to this circuit is the voltage of the voltage source, $v_i(t)$. The output is the voltage $v_o(t)$. The network function is $\mathbf{H}(\omega) = \frac{\mathbf{V}_o(\omega)}{\mathbf{V}_i(\omega)}$. Determine the values of the corner frequencies, *p* and *z*, and of the low-frequency gain, *k*.




**Solution:**
Represent the circuit in the frequency domain:




Using voltage division, the network function is:

$$\mathbf{H}(\omega) = \frac{\mathbf{V}_o(\omega)}{\mathbf{V}_i(\omega)} = \frac{R_2 + j\omega L}{R + R_2 + j\omega L}$$

$$= \left(\frac{R_2}{R + R_2}\right)\left(\frac{1 + j\omega \frac{L}{R_2}}{1 + j\omega \frac{L}{R + R_2}}\right)$$

With the given values:

$$\mathbf{H}(\omega) = \frac{(0.2)(1 + j(0.2)\omega)}{1 + j(0.04)\omega} \quad \Rightarrow \quad \begin{cases} k = 0.2 \\ z = \frac{1}{0.2} = 5 \\ p = \frac{1}{0.04} = 25 \end{cases}$$