Problema 1: análisis de circuitos RLC.

1.

$$\frac{V_o}{V_i} = \frac{1}{LCs^2 + RCs + 1}$$

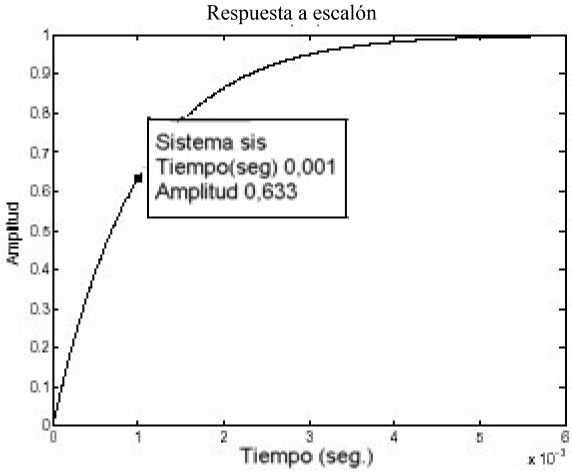
2.

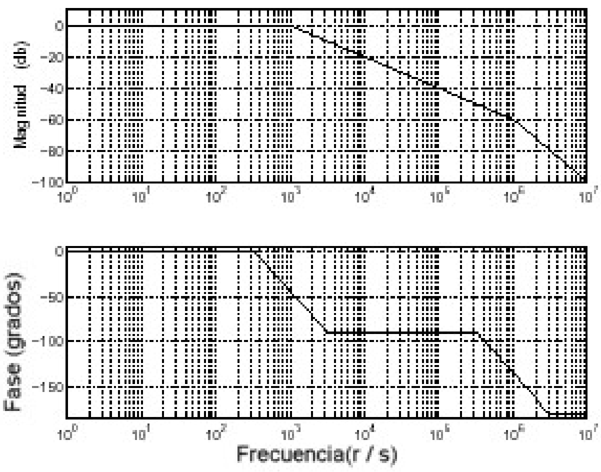
$$\begin{aligned}
\omega_n &= 2 * \pi * 5000 = 31.400\, r/s = \frac{1}{\sqrt{LC}} \\
L &= \frac{1}{\omega^2{}_n C} = 0{,}001\, H = 1\, mH \\
\frac{R}{L} &= 2\zeta\omega_n = 2 * 0{,}707 * 31.400 \\
R &= 44{,}4\, \Omega
\end{aligned}$$

3. No hay ceros ni polos en las raíces de:

$$\begin{aligned}
s^2 + \frac{1000}{0{,}001}s + \frac{1}{1e-6 * 1e-3} &= 0 \\
s_1 &\approx -1e6 \\
s_2 &\approx -1e3 \text{ polo dominante} \\
x_{ss} = 1 &
\end{aligned}$$

Respuesta a escalón





4.

5. $s = -1e3 = s_2$

6.

$$\text{Para un circuito con R\&C en } \| \frac{v_o}{v_i} = \frac{R_2}{R_2LCs^2 + (R_1R_2C + L)s + R_1 + R_2}$$
$$\text{Para un circuito con R \& C en serie } \frac{v_o}{v_i} = \frac{R_2Cs + 1}{LCs^2 + (R_1 + R_2)Cs + 1}$$

Problema 2: amplificador operacional

1.

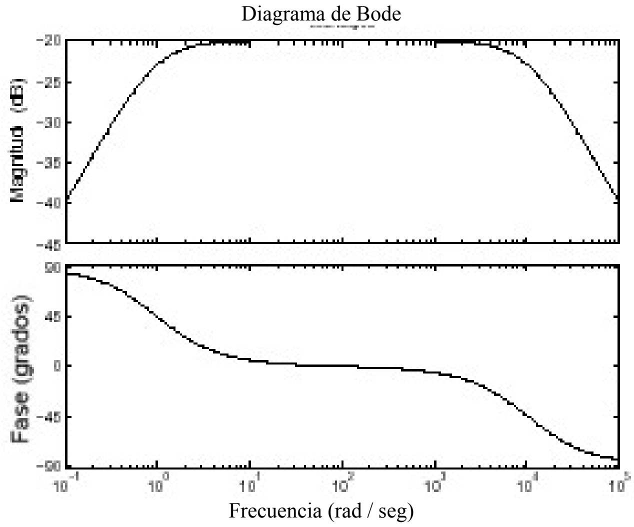
$$\frac{v_o}{v_i} = \frac{R_2C_1s}{(R_2C_2s + 1)(R_1C_1s + 1)}$$

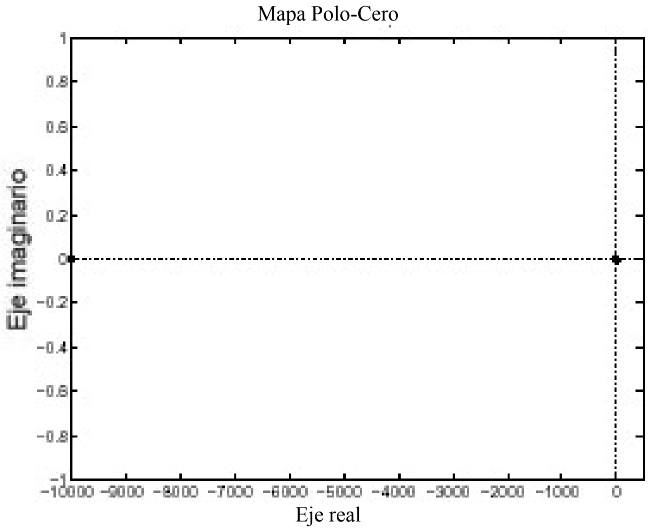
2.

$$M(\omega) = \frac{R_1C_1\omega}{\sqrt{(1 - R_1R_2C_1C_2\omega^2)^2 + ((R_1C_1 + R_2C_2)\omega)^2}}$$
$$\phi(\omega) = 90^\circ - \tan^{-1}\left(\frac{(R_1C_1 + R_2C_2)\omega}{(1 - R_1R_2C_1C_2\omega^2)}\right)$$

3.

4.





Problema 3

1.

$$\begin{aligned} T(s) &= \frac{K}{s^2+20s+K} \\ \omega_n &= \sqrt{K} \\ 2\zeta\omega_n &= 2\sqrt{K} = 20 \\ K &= 100 \end{aligned}$$

2.

$$\begin{aligned} \frac{V_{out}}{V_1} &= \frac{(s+3)(6s+1)}{(s+3)(6s+1)+(8s+7)} \\ \frac{V_{out}}{V_2} &= \frac{(6s+1)}{(s+3)(6s+1)+(8s+7)} \end{aligned}$$

3. Resuélvalo utilizando la superposición:

$$
\begin{aligned}
V_{out}(6s^2+27s+10) &= V_1(6s^2+19s+3)+V_2(6s+1) \\
6\ddot{V}_{out}+27\dot{V}_{out}+10V_{out} &= 6\ddot{V}_1+19\dot{V}_1+3V_1+6\dot{(V)}_2+V_2
\end{aligned}
$$

Problema 4

La función de transferencia para este sistema es:

$$
\begin{aligned}
\frac{x(s)}{f(s)} &= \frac{1}{m_{eq}s^2+cs+k} \\
\omega_n &= \sqrt{\frac{k}{m_{eq}}} \\
2\zeta\omega_n &= \frac{c}{m_{eq}}
\end{aligned}
$$

1. A partir del gráfico, medimos lo siguiente:

$$
\begin{aligned}
T &\approx 1{,}0s \Rightarrow \ \omega_d = \frac{2\pi}{T} = 6{,}28r/s \\
\omega_d &= \omega_n\sqrt{1-\zeta^2} \\
M_p &\approx 100\frac{0{,}75 \text{ - } 0{,}5}{0{,}5} = 50 \\
\zeta &= \frac{A}{\sqrt{\pi^2+A^2}} = 0{,}215 \\
A &= ln\frac{100}{M_p} = 0{,}693 \\
\omega_n &= 6{,}43r/s \\
m_{eq} &= \frac{\omega_n^2}{k} = 4{,}8 \approx 5kg \\
c &= 2\zeta\omega_n m_{eq} = 13{,}8Ns/m \approx 14Ns/m
\end{aligned}
$$

Si no, puede determinar ς mediante el método de decremento logarítmico.

2.

$$
\begin{aligned}
m_{eq} &= m+\frac{I}{r^2} \\
I &= 0{,}5\ kg\ m^2
\end{aligned}
$$

Problema 5

La función de transferencia para este sistema es:

$$\begin{aligned}\frac{\omega(s)}{\phi(s)} &= \frac{k}{Js^2+cs+k}\\ \text{Por lo tanto } \omega_n &= \sqrt{\frac{k}{J}}\\ 2\zeta\omega_n &= \frac{c}{J}\end{aligned}$$

1. Existen un par de formas para resolver esta parte del problema. En primer lugar, puede leer $\omega_n = 9\,r/s$ y $M_p = 5\ dB$ del diagrama de Bode y utilizar las relaciones siguientes:

$$\begin{aligned}M_p &= \frac{1}{2\zeta\sqrt{1-\zeta^2}}\\ \omega_r &= \omega_n\sqrt{1-2\zeta^2}\end{aligned}$$

   para hallar $\varsigma \approx 0{,}3$ y $\omega_n \approx 10\,r/s$. O puede leer $\omega_n = 10\,r/s$ directamente del diagrama de fase ($\theta = -90^{\circ}$).

2. $k = 1500\ Nm/r$, $c = 90 Nms/r$

3.

$$\begin{aligned}\omega = 1{,}1\ r/s\ \ \theta(t) &\approx \sin(1{,}1t+0)\\ \omega = 10\ r/s\ \ \theta(t) &\approx 1{,}58\sin(10t-\pi/2)\\ \omega = 20\ r/s\ \ \theta(t) &\approx 0{,}3\sin(20t-2{,}75)\end{aligned}$$