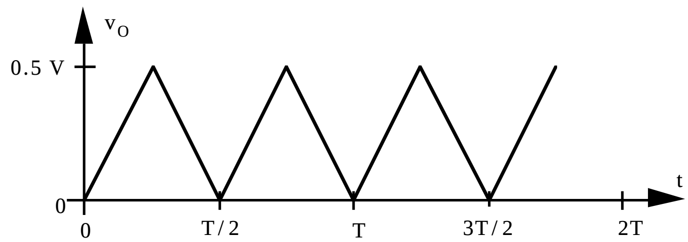
Homework Assignment No. 15

1.) Problem 12.61 (12.122) of the text.

For $R_3 = R_2$,



2.) Problem 12.67 (12.128) of the text.

$$\text{For } V_O = 4.3 + 0.6 = 4.9V: \ V_+ = 4.9\frac{4.3k\Omega}{4.3k\Omega + 39k\Omega} = 0.487\ V$$

$$\text{For } V_O = -4.3 - 0.6 = -4.9V: \ V_+ = -4.9\frac{4.3k\Omega}{4.3k\Omega + 39k\Omega} = -0.487\ V$$

$$V_N = 0.487 - (-0.487) = 0.974\ V$$

3.) Problem 12.69 (12.130) of the text.

$$\text{For } v_O = +12V: \ V_+ = 6\frac{24k\Omega}{3.4k\Omega + 24k\Omega} + 12\frac{3.4k\Omega}{3.4k\Omega + 24k\Omega} = 6.74\ V$$

$$\text{For } v_O = 0V: \ V_+ = 6\frac{24k\Omega}{3.4k\Omega + 24k\Omega} = 5.26\ V$$

$$v(t) = V_F - (V_F - V_I)\exp\left(-\frac{t}{RC}\right)$$

$$6.74 = 12 - (12 - 5.26)\exp\left(-\frac{T_1}{RC}\right) \rightarrow T_1 = 6200\left(3.3x10^{-8}\right)\ln\frac{6.74}{5.26} = 50.7\ \mu s$$

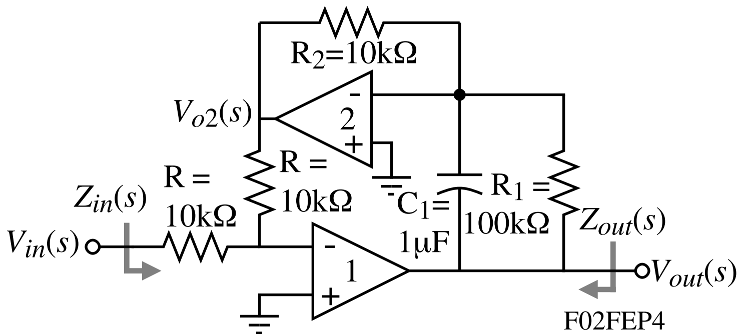
$$5.26 = 0 - (0 - 6.74)\exp\left(-\frac{T_2}{RC}\right) \rightarrow T_2 = 6200\left(3.3x10^{-8}\right)\ln\frac{6.74}{5.26} = 50.7\ \mu s$$

$$f = \frac{1}{50.7\mu s + 50.7\mu s} = 9.86\ kHz$$

4.) Problem 12.70 (12.131) of the text.

f = 0. The circuit does not oscillate. $V_O = 0$ is a stable state.

5.) If the op amps shown are ideal (infinite voltage gain, infinite differential input resistance, and zero output resistance) find the voltage transfer function, $V_{out}(s)/V_{in}(s)$, the input impedance, $Z_{in}(s)$, and the output impedance, $Z_{out}(s)$. Sketch an asymptotic plot for the magnitude and phase shift of the voltage transfer function, $V_{out}(i\omega)/V_{in}(j\omega)$ as a function of $\log_{10}\omega$.



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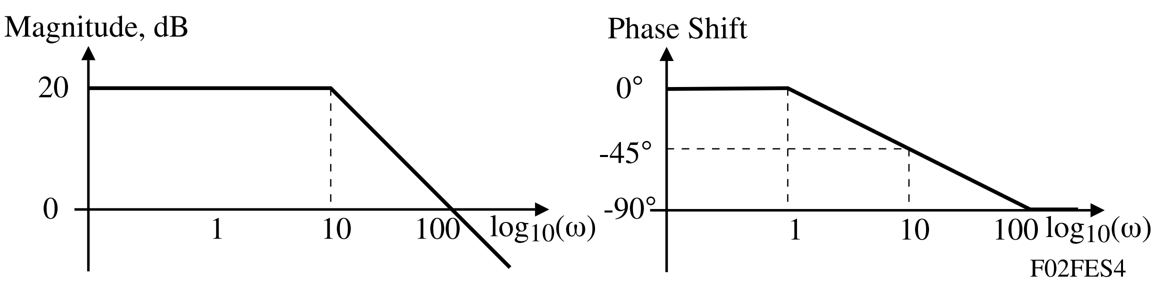
Solution

$V_{o2}(s)$ can be written as $V_{o2}(s) = -\frac{R_2}{Z_1}v_{out}(s)$. Thus, the currents flowing toward the inverting terminal of the 1st op amp are, $\frac{V_{in}(s)}{R} + \frac{V_{o2}(s)}{R} = \frac{V_{in}(s)}{R} - \frac{R_2}{Z_1(s)}\frac{V_{out}(s)}{R} = 0$

$$\therefore \frac{V_{out}(s)}{V_{in}(s)} = \frac{Z_1(s)}{R_2} = \frac{1}{R_2}\frac{R_1(1/sC_1)}{R_1+(1/sC_1)} = \frac{R_1}{R_2}\frac{1}{sR_1C_1+1} \qquad \boxed{\frac{V_{out}(s)}{V_{in}(s)} = \frac{R_1}{R_2}\frac{1}{sR_1C_1+1}}$$

By inspection, $\boxed{Z_{in}(s) = R = 10\text{k}\Omega \text{ and } Z_{out}(s) = 0}$

For the Bode plot we want to plot the magnitude and phase of $\frac{V_{out}(j\omega)}{V_{in}(j\omega)} = \frac{10}{1+j\omega/10}$.



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