Lab 4

Wednesday, November 5, 2025 12:42 PM

Exercise 2:

1) $\frac{V_2 - V_1}{R_2} = I$

$\frac{0.1}{R_2} = 1E\text{-}6$

$R_2 = \frac{0.1}{1E\text{-}6} = 100\,k\Omega$

2) $\frac{R_4}{R_3 + R_4} = \frac{1}{10}$

$\frac{R_4}{R_3} = \frac{1}{9}$

we can choose

$R_4 = 22\,k\Omega$, $R_3 = 200\,k\Omega$

Which yields:

$\frac{22}{22+200} \cdot 5 = 0.4955\,V$

3) $Q = CV$

$I = C\dot{V}$

$I = sCV$

$Z_C = \frac{1}{sC}$

$\left| \frac{R}{R + \frac{1}{j\omega C}} \right| = \frac{1}{2}$

$\left| \frac{j\omega RC}{j\omega RC + 1} \right| = \frac{1}{\sqrt{2}}$

$\frac{(\omega RC)^2}{1 + (\omega RC)^2} = \frac{1}{2}$

$2(\omega RC)^2 = 1 + (\omega RC)^2$

$\omega RC = 1$

$RC = \frac{1}{\omega}$

$= \frac{1}{2\pi \cdot 100}$

$= 1.59155E\text{-}3\,s$

$R_5 = 1.6\,k\Omega$

$C_1 = 1\,HF$ are close

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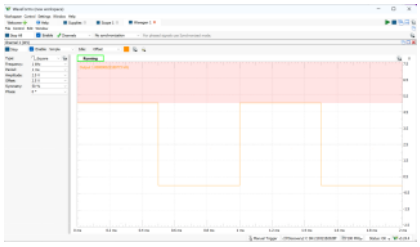
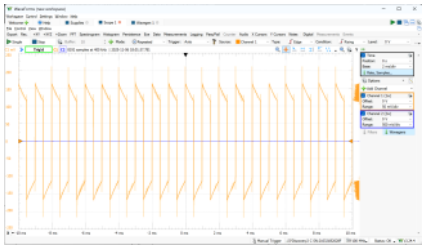
4)

5)

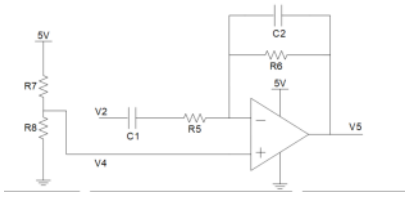


6)



7)

Exercise 3:

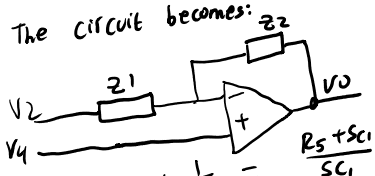


1) $\frac{R8}{R8+R7} = \frac{1}{2}$

$R8 = R7$

$R8 = R7 = 10k\Omega$ works

The circuit becomes:



$Z1 = R5 + \frac{1}{SC_1} = \frac{R5+SC_1}{SC_1}$

$Z2 = R6 \| \frac{1}{SC_2} = \frac{R6/SC_2}{R6+\frac{1}{SC_2}}$

$= \frac{R6}{1+SR6C_2}$

So

$V_0 = V_4(1+\frac{Z2}{Z1}) - V_2(\frac{Z2}{Z1})$

so

$V_o = V_4\left(1+\frac{Z_2}{Z_1}\right) - V_2\left(\frac{Z_2}{Z_1}\right)$

$V_o = V_4 + \frac{Z_2}{Z_1}(V_4 - V_2)$

we want $\left|\frac{Z_2}{Z_1}\right| = 10$

$$\frac{\frac{R_6}{1+sR_6C_2}}{R_5+\frac{1}{sC_1}} = \frac{R_6\left(\frac{1}{1+sR_6C_2}\right)}{R_5\left(1+\frac{1}{sR_5C_1}\right)}$$

$$= \frac{R_6}{R_5}\left(\frac{sR_5C_1}{1+sR_5C_1}\right)\left(\frac{1}{1+sR_6C_2}\right)$$

so we pick $\frac{R_6}{R_5} = 10$

$\boxed{R_6 = 16\,k\Omega,\ R_5 = 16\,k\Omega}$

2) $\left|\frac{1}{1+j\omega R_6C_2}\right| = \frac{1}{\sqrt{2}}$

$2 = 1 + (\omega R_6C_2)^2$

$1 = \omega R_6C_2$

$C_2 = \frac{1}{R_6\omega}$

$= \frac{1}{16E3 \cdot 16E3 \cdot 2\pi}$

$= \boxed{0.622\ nF}$, since $\omega > 16E3$:

pick

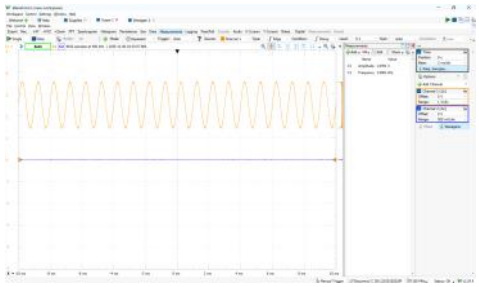
$C_2 \leq \boxed{0.622\ nF} = \boxed{620\ pF}$

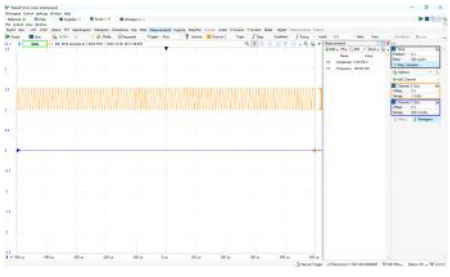
Let's choose the highest capacitor we have, which is

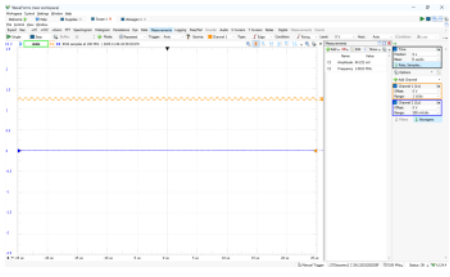
$C_2 = 100\ pF$, this has a cut off frequency of:

$\omega = \frac{1}{RC} = \frac{1}{16E3 \cdot 100E-12} = 625\ E3\ rad/s = 99.5\ kHz$

3)







4)

5)

6)

Phase 2:

Exercise 4:

1) $V_6 = \frac{R_g}{R_g + \frac{1}{C_1 s}} V_5$

$R_g = 1.6k\Omega$, $C_1 = 1\mu F$

2) $V_7 = V_6\left(1 + \frac{R_{11}}{R_{10}}\right)$

$\frac{R_{11}}{R_{10}} = 10$

$R_{10} = 1k\Omega$, $R_{11} = 10k\Omega$ works

3) $V_8 = \frac{\frac{1}{sC_4}}{\frac{1}{sC_4} + R_{12}} V_7$

$V_8 = \frac{1}{1 + R_{12} sC_4} V_7$

$\left|\frac{1}{1 + R_{12} sC_4}\right| = \frac{1}{\sqrt{2}}$

$1 = R_{12} C_4 \omega$

$R_{12} C_4 = \frac{1}{\omega}$

$= \frac{1}{1.6 \cdot 2\pi}$

$= 9.95E{-}2$

$C_4 = 100\ nF$

$R_{12} = 1\ M\Omega$

4)