The circuit above is exposed to the input voltage $V_i$ as shown. Sketch the output, $V_o$. At what times does $V_o = 53$ mV?

(Resistances in kΩ. Voltages in V. Current in mA)

Output is a rising exponential

Time constant: $\tau = 228.9$ ms

At time $\Delta t$ after $t = 21$.

$$53 = 162 \left(1 - \exp\left(-\frac{\Delta t}{\tau}\right)\right)$$

$$\frac{53}{162} = 1 - \exp\left(-\frac{\Delta t}{\tau}\right)$$

$$1 - \frac{53}{162} = \exp\left(-\frac{\Delta t}{\tau}\right)$$

$$\Delta t = -\tau \log\left(1 - \frac{53}{162}\right)$$

$$t = 21 + 90.7 = 111.7$$ ms
$V_i$ is a sinusoidal waveform with frequency $\omega = 2\pi f$.

- Calculate a (simplified) expression for $H(\omega) = \frac{V_o}{V_i}$
- What is $H(\omega)$ when $\omega \to 0$ (very low frequency)?
- What is $H(\omega)$ when $\omega \to \infty$ (HF)?

\[ H(\omega) = \frac{3.9 + \frac{1}{j\omega 58.7}}{1.2 + \frac{1}{j\omega 33.1} + 3.9 + \frac{1}{j\omega 58.7}} \]

\[ H(\omega) = \frac{3.9 + \frac{0.0170}{j\omega}}{5.1 + \frac{0.0472}{j\omega}} \]

\[ H(\omega) = 0.7647 \frac{1 + \frac{1}{j\omega 15.08}}{1 + \frac{1}{j\omega 4.15}} \]

- What is $H(\omega)$ when $\omega = 0$ (DC)? Answer = 0.7647
- What is $H(\omega)$ when $\omega \to \infty$ (HF)? Answer = 0.21
In the circuit above, \( V_1 \) is 1.6 V, and \( V_2 \) is 3.1 V.

- What is the value of \( V_o \)?
- How much current flows out of \( V_1 \)?

(Resistances in kΩ. Voltages in V. Current in mA)

**Loop 1:**
- \( 1.6 - i_1 3.9 + 3.1 - (i_1 + i_2) 3.9 = 0 \).
- \( 4.7 = i_1 7.8 + i_2 3.9 \)
- \( i_1 = \frac{4.7 - i_2 3.9}{7.8} = 0.60 - i_2 0.50 \)

**Loop 2:**
- \( 3.1 - (i_1 + i_2) 3.9 - i_2 32.7 - i_2 33.1 = 0 \).
- \( 3.1 = i_1 3.9 + i_2 69.7 \)
- \( 3.1 = 2.34 - i_2 1.95 + i_2 69.70 = 2.34 + i_2 67.75 \)
- \( 0.76 = i_2 67.75 \)
- \( i_2 = 0.0112 \)
- \( V_o = -i_2 32.7 = -0.36624 \) (What is the value of \( V_o \)?)
- \( i_1 = 0.60 - i_2 0.50 = 0.5944 \)
- \( i_1 + i_2 = 0.6056 \) (How much current flows out of \( V_1 \)?)