1. What is the current $i(t)$ in the circuit shown below when $t = 3\, \text{ms}$? The source is $e(t) = 10\, \text{V}u(t)$ where $u(t)$ is the unit step function. The component values are: $R_1 = 6.8\, \text{k}\Omega$, $R_2 = 2.4\, \text{k}\Omega$, $R_3 = 5.1\, \text{k}\Omega$, and $C = 0.22\, \mu\text{F}$.

\[
V_c(t) = E \left[1 - e^{-\frac{t}{\tau}}\right] u(t) + V_c(0^-) e^{-\frac{t}{\tau}} u(t)
\]

\[
i_c(t) = \frac{E}{R} e^{-\frac{t}{\tau}} u(t)
\]

$\tau = RC$

$E_0 = 10\, \text{V}$

\[
E = E_0 \frac{R_2}{R_2 + R_3} = 3.2\, \text{V}
\]

$R = R_1 + R_2 || R_3 = 8.432\, \text{k}\Omega$

$\tau = RC = 1.855\, \text{ms}$

$t = 3\, \text{ms}$

\[
V_c = E \left[1 - e^{-\frac{t}{\tau}}\right] = 2.565\, \text{V}
\]

\[
i_c = \frac{E}{R} e^{-\frac{t}{\tau}} = 0.075\, \text{mA}
\]

\[
V_2 = V_c + R_1 i_c = 3.077\, \text{V}
\]

\[
i_2 = \frac{V_2}{R_2} = 1.282\, \text{mA}
\]

\[
i = i_2 + i_c = 1.357\, \text{mA}
\]

\[
i(t) = 1.36\, \text{mA}
\]
2. The excitation, $i_o(t)$, in the circuit shown below is $i_o(t) = 10 \text{mA}u(t)$. Determine the current $i(t)$ when $t = 0.1 \mu s$. The component values are: $R_1 = 20 \Omega$, $R_2 = 33 \Omega$, $R_3 = 15 \Omega$, $R_4 = 11 \Omega$, and $L = 3 \text{mH}$.

\[
\begin{align*}
E &= I_o \frac{R_4}{R_2 + R_3 + R_4} \quad R_2 = 61.525 \text{V} \\
R &= R_1 + R_2 \left( \frac{1}{R_3 + R_4} \right) = 34.542 \Omega \\
G &= \frac{1}{R} = 28.95 \mu \Omega \\
I &= \frac{E}{R} = 1.781 \text{mA} \\
\gamma &= GL = 0.0087 \mu \text{s} \\
i_L &= I \left[ 1 - e^{-\frac{t}{\gamma}} \right] = 1.218 \text{mA} \\
v_L &= \frac{I}{G} e^{-\frac{t}{\gamma}} = 19.454 \text{V} \\
v_2 &= v_L + R_1 i_L = 43.813 \text{V} \\
i_2 &= \frac{v_2}{R_2} = 1.328 \text{mA} \\
i &= -[i_L + i_2] = -2.546 \text{mA} \\
i(t) &= -2.55 \text{mA} \quad 10 \\
\end{align*}
\]
3. Determine the complex transfer function $\tilde{T}(s)$ for the circuit shown below. Specify it as a function of the complex frequency, $s$, and the symbols for the resistors and capacitor and as a the ratio of two polynomials in $s$. Plot the magnitude of the complex transfer function $|\tilde{T}(j\omega)|$ in decibels as a function of the frequency $\omega$ of the source as $\omega$ varies from 1 Hz to 1 MHz. The component values are $R_1 = 2\,k\Omega$, $R_2 = 470\,k\Omega$, $R_3 = 1\,k\Omega$, $R_4 = 1\,k\Omega$, and $C = 10\,nF$. Use the numerical values given for the resistors and capacitors. If applicable, determine the pole and zero frequencies as well as the high and low frequency gains.

\[
T(0) = \frac{R_3}{R_1 + R_2 + R_3} = K_T
\]

\[
T(\infty) = \frac{R_3}{R_1 + R_3} = K_H
\]

\[
\therefore \text{helenu}
\]

\[
\tilde{T}(s) = \frac{1}{s} \frac{1 + \frac{R_2}{R_1 + R_2 + R_3}}{1 + \frac{1}{(R_4 + R_2)(R_1 + R_3)}}
\]

\[
|\tilde{T}(0)|_{dB} = 20 \log_{10} \left| \frac{R_3}{R_1 + R_2 + R_3} \right| = -53.497 \text{ dB}
\]

\[
|\tilde{T}(\infty)|_{dB} = 20 \log_{10} \left| \frac{R_3}{R_1 + R_3} \right| = -12.037 \text{ dB}
\]

\[
f_p = \frac{1}{2\pi \tau_p} = 3.998 \text{ Hz}
\]

\[
f_z = \frac{1}{2\pi \tau_z} = 33.791 \text{ Hz}
\]
4. Indicate with an F (floating) or G (grounded) whether the following laboratory instruments input or output connectors are floating or grounded with respect to the ac power line ground

- F Keysight 34401A Digital Multimeter
- G Keysight DSO-X 3012A Oscilloscope
- F Keysight 3630A Triple Output dc Power Supply
- F Keysight 33522A Function Generator/Arbitrary Waveform Generator
- F Fluke/Philips 6303 LCR Meter

The names of the three wires connected to a standard 120 Volt AC outlet are the ________ wire which is covered with ________ colored insulation, the ________ wire which is covered with ________ colored insulation, and the ________ which is covered with ________ colored insulation.

2 each

3 try
1. What is the current \( i(t) \) in the circuit shown below when \( t = 7.3 \text{ ms} \)? The source is \( i_o(t) = 10 \text{ mA}u(t) \) where \( u(t) \) is the unit step function. The component values are: \( R_1 = 12 \text{ k}\Omega, \ R_2 = 30 \text{ k}\Omega, \ R_3 = 7.5 \text{ k}\Omega, \ R_4 = 24 \text{ k}\Omega, \) and \( C = 0.22 \mu\text{F} \).

\[
V_c(t) = E\left[1 - e^{-\frac{t}{\tau}}\right]u(t) \\
I_o(t) = 10 \text{ mA} \\
i_o(t) = I_o u(t)
\]

\[
\tau = RC = 6.02 \text{ ms} \\
t = 7.3 \text{ ms}
\]

\[
E = I_o \frac{R_y}{R_2 + R_3 + R_4} \\
R = R_1 + \frac{R_2}{R_3 + R_4} = 27.366 \text{ k}\Omega \\
\tau = RC = 6.02 \text{ ms} \\
V_c = E\left[1 - e^{-\frac{t}{\tau}}\right] = 82.25 \text{ V} \\
i_c = \frac{E}{R} e^{-\frac{t}{\tau}} = 1.272 \text{ mA}
\]

\[
v_2 = V_c + R_1 i_c = 97.52 \text{ V} \\
v_2 = \frac{V_2}{R_2} = 3.281 \text{ mA}
\]

\[
i = -\left[i_2 + i_c\right] = -4.523 \text{ mA}
\]

\[
i(t) = -4.52 \text{ mA}
\]
2. The excitation, \( e(t) \), in the circuit shown below is \( e(t) = 18 \ u(t) \) V. Determine the current \( i(t) \) when \( t = 0.3 \mu s \). The component values are: \( R_1 = 11 \) k\( \Omega \), \( R_2 = 33 \) k\( \Omega \), \( R_3 = 30 \) k\( \Omega \), and \( L = 5 \) mH.

\[
\dot{L}_L(t) = I \left[ 1 - e^{-\frac{t}{\tau}} \right] u(t) + V_L
\]

\[
V_L(t) = \frac{I}{G} e^{-\frac{t}{\tau}} u(t)
\]

\[\tau = RC\]

\[E = \frac{E_0 \frac{R_2}{R_2 + R_3}}{R_1 + R_2 || R_3} = 9.429 \text{ V}\]

\[R = R_1 + R_2 || R_3 = 26.714 R\]

\[I = \frac{E}{R} = 0.353 \text{ mA}\]

\[G = \frac{1}{R} = 37.43 \mu \text{S}\]

\[\tau = GR = 0.187 \mu \text{s}\]

\[I_L = I \left[ 1 - e^{-\frac{t}{\tau}} \right] = 0.282 \text{ mA}\]

\[V_L = \frac{I}{G} e^{-\frac{t}{\tau}} = 1.898 \text{ V}\]

\[V_2 = V_L + R_1 \dot{L}_L = 4.997 \text{ V}\]

\[I_Z = \frac{V_2}{R_2} = 0.151 \text{ mA}\]

\[I = I_L + I_Z = 0.433 \text{ mA}\]

\[i(t) = 0.433 \text{ mA}\]
3. Determine the complex transfer function \( \bar{T}(s) \) for the circuit shown below. Specify it as a function of the complex frequency, \( s \), and the symbols for the resistors and capacitor and is the form of the ratio of two polynomials in \( s \). Plot the magnitude of the complex transfer function \( \bar{T}(j\omega) \) in decibels as a function of the frequency \( f \) of the source as \( f \) varies from 1 Hz to 1 MHz. The component values are \( R_1 = 300 \, \text{k}\Omega \), \( R_2 = 3 \, \text{k}\Omega \), \( R_3 = 1 \, \text{k}\Omega \), \( R_4 = 2 \, \text{k}\Omega \), and \( C = 1 \, \text{nF} \). Use the numerical values given for the resistors and capacitors. If applicable, determine the pole and zero frequencies as well as the high and low frequency gains.

\[
T(0) = \frac{R_3}{R_1 + R_2 + R_3}
\]

\[
T(\omega) = \frac{R_3}{R_1 || R_4 + R_2 + R_3}
\]

\[
\bar{T}(s) = \frac{1 + 2\pi \gamma_2}{1 + 2\pi \gamma_p} = \frac{R_3}{R_1 + R_2 + R_3} \frac{1 + 2\gamma_p (R_1 + R_4)}{1 + 2\gamma_p}
\]

\[
|\bar{T}(0)|_{dB} = 20 \log_{10} \left| \frac{R_3}{R_1 + R_2 + R_3} \right| = -49.657 \, \text{dB}
\]

\[
|\bar{T}(\omega)|_{dB} = 20 \log_{10} \left| \frac{R_3}{R_1 || R_4 + R_2 + R_3} \right| = -15.544 \, \text{dB}
\]

\[
f_p = \frac{1}{2\pi \gamma_p} = 2.6761 \, \text{kHz}
\]

\[
f_z = \frac{1}{2\pi \gamma_z} = 527.003 \, \text{Hz}
\]
4. Indicate with an F (floating) or G (grounded) whether the following laboratory instruments input or output connectors are floating or grounded with respect to the ac power line ground

F  Keysight 34401A Digital Multimeter
G  Keysight DSO-X 3012A Oscilloscope
F  Keysight 3630A Triple Output dc Power Supply
F  Keysight 33522A Function Generator/Arbitrary Waveform Generator
F  Fluke/Philips 6303 LCR Meter

The names of the three wires connected to a standard 120 Volt AC outlet are the [__] wire which is covered with [__] colored insulation, the [__] wire which is covered with [__] colored insulation, and the [__] which is covered with [__] colored insulation.

2 each
3 try
Mean 74.96808511
Median 78.5
Standard Deviation 22.48892302
Mode 100
Max 100
Min 0
Number 94