1. What is the current $i(t)$ in the circuit shown below when $t = 7.3$ ms? The voltage source is $e(t) = 10\, V\, u(t)$ where $u(t)$ is the unit step function. The component values are: $R_1 = 20\, k\Omega$, $R_2 = 24\, k\Omega$, $R_3 = 15\, k\Omega$, and $C = 0.22\, \mu F$.

\[ V_c(t) = E \left[ 1 - e^{-\frac{t}{RC}} \right] u(t) \]
\[ i_c(t) = \frac{E}{R} e^{-\frac{t}{RC}} u(t) \]
\[ \gamma = RC = 5.7 \text{ ms} \]
\[ V_c = E \left[ 1 - e^{-\frac{t}{RC}} \right] = 3.94 \]
\[ i_c = \frac{E}{R} e^{-\frac{t}{RC}} = 0.058 \text{ mA} \]
\[ i_2 = \frac{V_c + R_3 i_c}{R_2} = 0.201 \text{ mA} \]
\[ i = i_2 + i_c = 0.259 \text{ mA} \]

\[ i(t) = 0.259 \text{ mA} \]

\[ \text{Try} \]
2. What is the current $i(t)$ in the circuit shown below when $t = 0.43 \mu s$? The voltage source is $e(t) = 10 V u(t)$ where $u(t)$ is the unit step function. The component values are: $R_1 = 13 \, \text{k}\Omega$, $R_2 = 12 \, \text{k}\Omega$, $R_3 = 6.8 \, \text{k}\Omega$, and $L = 3 \, \text{mH}$.

\[ i_L(t) = I \left[ 1 - e^{-\frac{t}{\tau}} \right] u(t) \]
\[ v_L(t) = \frac{I}{G} e^{-\frac{t}{\tau}} u(t) \]
\[ e(t) \]

\[ \gamma = GL \]

\[ E = E_0 \frac{R_2}{R_1 + R_2} = 4.8 \text{V} \]
\[ R = R_3 + R_1 \parallel R_2 = 13 \, \text{k}\Omega \]

\[ I = \frac{E}{R} = 0.368 \text{mA} \]
\[ G = \frac{1}{\tau} = 76.7 \, \mu \text{T} \]

\[ R = R_3 + R_1 \parallel R_2 = 13 \, \text{k}\Omega \]
\[ E = E_0 \frac{R_2}{R_1 + R_2} = 4.8 \text{V} \]

\[ I = \frac{E}{R} = 0.368 \text{mA} \]
\[ \gamma = GL = 0.23 \, \mu \text{s} \]

\[ i_L = I \left[ 1 - e^{-\frac{t}{\tau}} \right] = 0.311 \text{mA} \]
\[ v_L = \frac{I}{G} e^{-\frac{t}{\gamma}} = 0.74 \text{V} \]
\[ v_2 = v_L + R_3 i_L = 2.857 \text{V} \]
\[ i_2 = \frac{v_2}{R_2} = 0.238 \text{mA} \]
\[ i = i_L + i_2 = 0.549 \text{mA} \]

\[ i(t) = 0.549 \text{mA} \]

5 10

556.5

\[ S \text{ try} \]

2
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 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 $f$ of the source as $f$ varies from 1 Hz to 1 MHz. The component values are $R_1 = 330\,k\Omega$, $R_2 = 2\,k\Omega$, $R_3 = 150\,k\Omega$, 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.

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

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

\[ \therefore s \text{ pole is} \]

\[ T(\omega) = j\omega \frac{1 + \alpha \gamma_2}{1 + \alpha \gamma_1} \]

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

\[ |\tilde{T}(0)|_{dB} = 20 \log_{10} \left| \frac{R_2}{R_1 + R_3} \right| = -10.1 \, dB \]

\[ |\tilde{T}(\infty)|_{dB} = 20 \log_{10} \left| \frac{R_2 || R_3}{R_2 || R_3 + R} \right| = -44.5 \, dB \]

\[ f_p = \frac{1}{2 \pi \left( \gamma_1 \right)} = \frac{1}{2 \pi \left[ R_2 + R_1 || R_3 \right] C} \]

\[ f_z = \frac{1}{2 \pi \left( \gamma_2 \right)} = \frac{1}{2 \pi \left[ R_2 C \right]} = 7.96 \, Hz \]
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 **black** wire which is covered with **black** colored insulation, the **white** wire which is covered with **white** colored insulation, and the **green** which is covered with **green** colored insulation.
1. What is the current $i(t)$ in the circuit shown below when $t = 7.3\,\text{ms}$? The voltage source is $e(t) = 10\,\text{V}u(t)$ where $u(t)$ is the unit step function. The component values are: $R_1 = 3\,\text{k}\Omega$, $R_2 = 10\,\text{k}\Omega$, $R_3 = 12\,\text{k}\Omega$, and $C = 0.33\,\mu\text{F}$.

\[ R = \frac{R_2 + R_1}{R_3} = 12.48\,\text{k}\Omega \quad E = E_0 \frac{R_3}{R_1 + R_3} = 8\,\text{V} \]
\[ v_c = E \left[1 - e^{-\frac{t}{RC}}\right] = 6.66\,\text{V} \quad i_c = \frac{E}{R} e^{-\frac{t}{RC}} = 0.108\,\text{mA} \]
\[ v_3 = v_c + R_2 i_c = 7.74\,\text{V} \]
\[ i_3 = \frac{v_3}{R_3} = 0.645\,\text{mA} \]
\[ i = i_c + i_3 = 0.753\,\text{mA} \]

\[ i(t) = 0.753\,\text{mA} \]
2. What is the current $i(t)$ in the circuit shown below when $t = 0.43 \mu s$? The voltage source is $e(t) = 18 \text{V}u(t)$ where $u(t)$ is the unit step function. The component values are: $R_1 = 39 \text{k}\Omega$, $R_2 = 13 \text{k}\Omega$, $R_3 = 30 \text{k}\Omega$, and $L = 3 \text{mH}$.

\[ V = iL \]

\[ e(t) \]

\[ i(t) \]

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

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

\[ i_L(t) = I \left[ 1 - e^{-\frac{t}{T}} \right] u(t) \]

\[ R = R_2 + R_1 + R_3 = 30 \Omega \]

\[ E = \frac{R_2}{R_1 + R_3} = 7.83 \text{V} \]

\[ I = \frac{E}{R} = 0.261 \text{mA} \]

\[ i_L = I \left[ 1 - e^{-\frac{t}{T}} \right] = 0.258 \text{mA} \]

\[ V_L = \frac{I}{G} e^{-\frac{t}{L}} = 0.107 \text{V} \]

\[ V_3 = V_L + R_2 i_L = 3.46 \text{V} \]

\[ i_3 = \frac{V_3}{R_3} \]

\[ i = i_L + i_3 = 0.373 \text{mA} \]

\[ i(t) = 0.373 \text{mA} \]

\[ \boxed{0.373 \text{mA}} \]

\[ 2 \text{ Strg} \]
3. Determine the complex transfer function \( T(s) \) 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 \( T(j\omega) \) 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 \( R_1 = 10 \, \text{k}\Omega \), \( R_2 = 330 \, \text{k}\Omega \), \( R_3 = 1 \, \text{k}\Omega \), 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.

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

\[
T(j\omega) = \frac{R_3}{R_1 + j\omega R_3}
\]

\[
T(s) = \frac{1 + 2 \frac{R_2}{R_3} s}{1 + (1 + 2 \frac{R_2}{R_3}) \frac{R_2}{R_3} s}
\]

\[
|T(0)\text{db}| = 20 \log_{10} \left| \frac{R_3}{R_1 + R_2 + R_3} \right| = -50.7 \text{dB}
\]

\[
|T(\infty)\text{db}| = 20 \log_{10} \left| \frac{R_3}{R_1 + R_3} \right| = -20.8 \text{dB}
\]

\[
f_p = \frac{1}{2\pi R_3} = \frac{1}{2\pi \left[ R_2 \parallel (R_1 + R_3) \right] C} = 152.1 \text{ Hz}
\]

\[
f_z = \frac{1}{2\pi R_2} = \frac{1}{2\pi R_2 C} = 482 \text{ Hz}
\]
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 [ ] wire which is covered with [ ] colored insulation.