First SPICE Exercise

Fundamentals Of Electronics - a.a. 2018-2019 - University of Padua (Italy)

Pietro Prandini (mat. 1097752)

April 26, 2019

1 Audio amplifier

1.1 Voltage gain and frequency domain - Ideal op. amp.

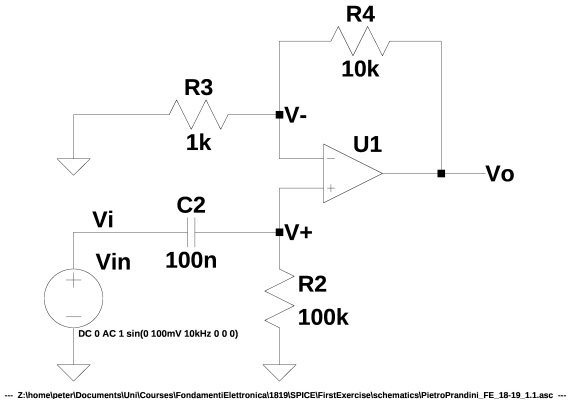

Figure 1: Audio amplifier - Ideal op. amp.

$$V_+ = V_{in}\frac{R_2\frac{1}{sC_2}}{R_2+\frac{1}{sC_2}} = V_{in}\frac{R_2\frac{1}{sC_2}}{R_2+\frac{1}{sC_2}}\frac{sC_2}{sC_2} = V_{in}\frac{R_2}{1+sC_2R_2}$$

$$V_- = V_+$$

$$I_{R_3} = \frac{V_-}{R_3} = \frac{V_+}{R_3} = V_{in}\frac{R_2}{1+sC_2R_2}\frac{1}{R_3}$$

$$I_{R_4} = I_{R_3}$$

$$V_o = V_+ + R_4 I_{R_4} = V_{in}\frac{R_2}{1+sC_2R_2} + V_{in}\frac{R_2}{1+sC_2R_2}\frac{R_4}{R_3} = V_{in}\frac{R_2}{1+sC_2R_2}\left(1+\frac{R_4}{R_3}\right)$$

$$\frac{V_o}{V_{in}} = \frac{R_2}{1+sC_2R_2}\left(1+\frac{R_4}{R_3}\right) = \frac{R_2}{1+sC_2R_2}\frac{R_3+R_4}{R_3} = \frac{R_2(R_3+R_4)}{R_3(1+sC_2R_2)} = \frac{R_2(R_3+R_4)}{R_3}\frac{1}{1+sC_2R_2}$$

$$K = \frac{R_2(R_3+R_4)}{R_3} = \frac{100\cdot 10^3(1\cdot 10^3+10\cdot 10^3)}{1\cdot 10^3} = 1.1\cdot 10^6$$

$$\log_{10}(K) = \log 10(1.1\cdot 10^6) \simeq 6$$

$$\omega_1 = \frac{1}{C_2R_2} = \frac{1}{100\cdot 10^{-9}\cdot 100\cdot 10^3} = 100$$

$$\log_{10}(\omega_1) = \log_{10}(100) = 2$$

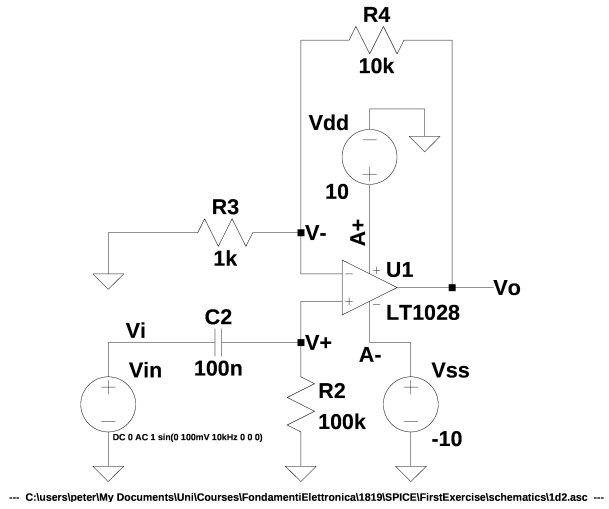

Figure 2: Audio amplifier - LT1028 op. amp.

1.2 Voltage output waveform - LT1028 op. amp.

1.2.1 Netlist

```
* Audio Amplifier - Waveform
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* Libraries
.LIB LTC.lib

* Amplifiers
XU1 V+ V- A+ A- Vo LT1028

* Capacitances
C2 V+ Vi 100n

* Generators
Vin Vi 0 DC 0 AC 1 sin(0 10mV {F} 0 0 0)
Vdd A+ 0 DC 10
Vss A- 0 DC -10

* Resistances
R2 V+ 0 100k
R3 V- 0 1k
R4 Vo V- 10k

* Analysis
.step param F list 1Hz 10Hz 100Hz
.tran 0 250m 0 1m uic

.END
```

1.2.2 Graph

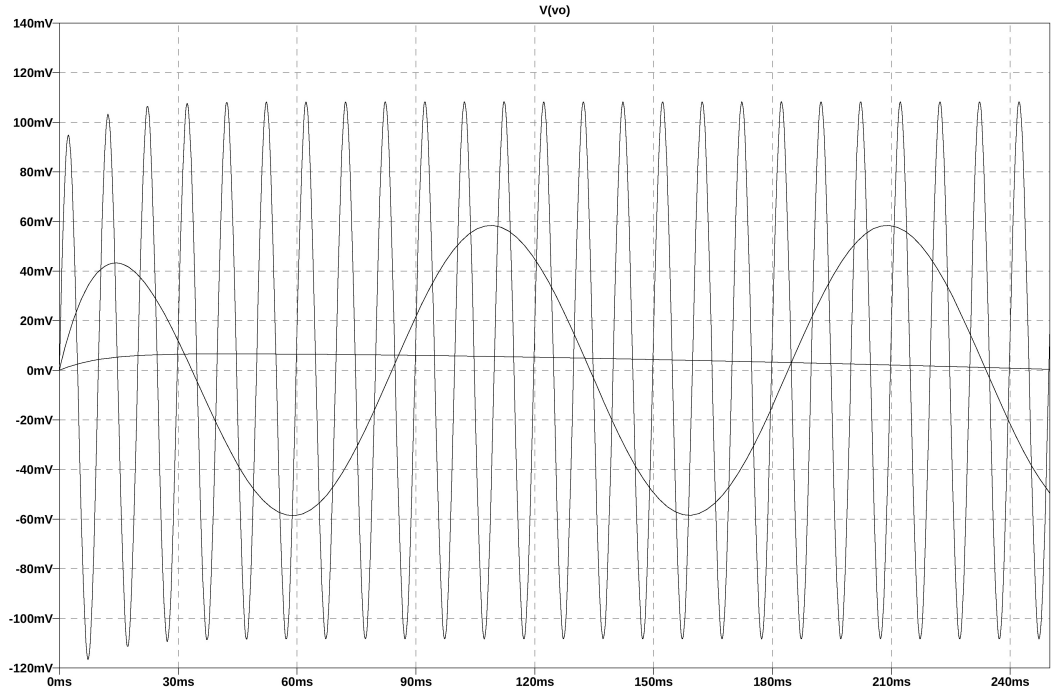

Figure 3: Audio Amplifier - Voltage output waveform

1.3 Bode diagram - LT1028 op. amp.

1.3.1 Netlist

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* Audio Amplifier - Bode diagram
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* Resistances
R2 V+ 0 100k
R3 V- 0 1k
R4 Vo V- 10k
```

```
* Analysis
.step param F list 1Hz 10Hz 100Hz
.ac DEC 10 1 100k

.END
```

1.3.2 Graph

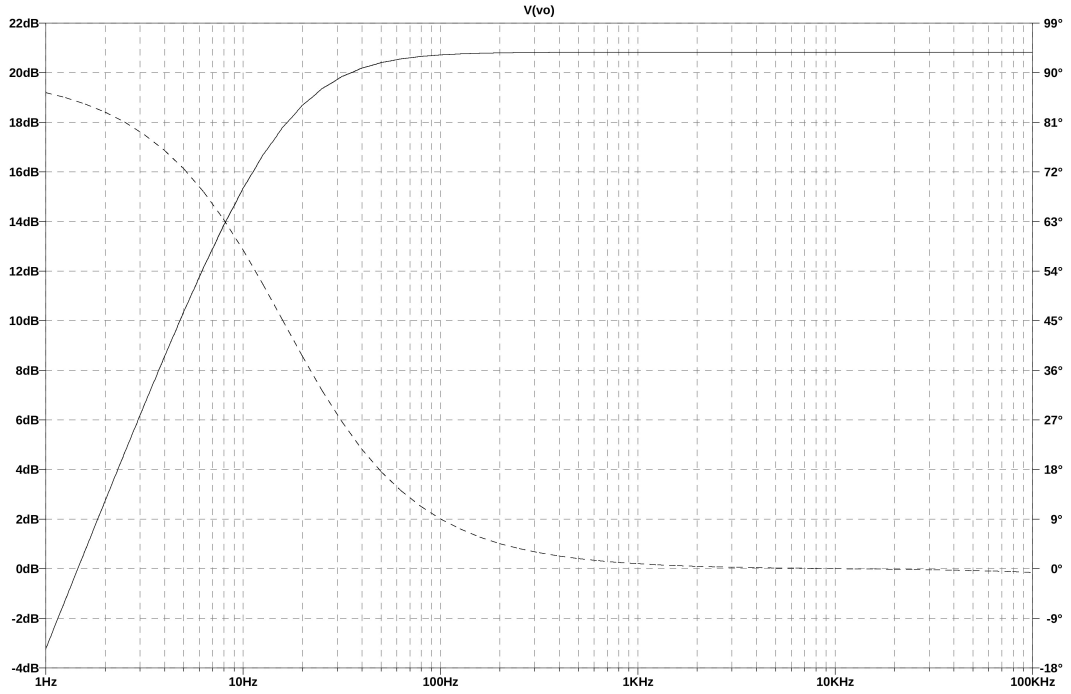

Figure 4: Audio Amplifier - Bode diagram