First SPICE Exercise

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

Pietro Prandini (mat. 1097752)

April 30, 2019

1 Audio amplifier

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

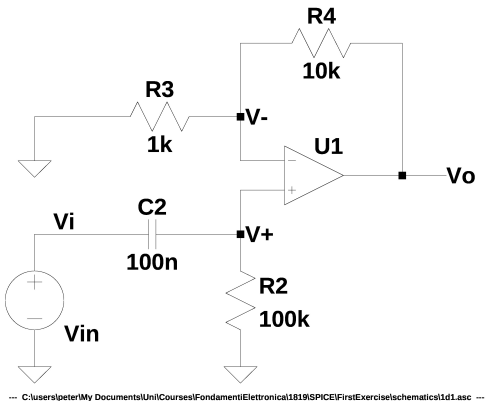

Figure 1: Audio amplifier - Ideal op. amp.

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

$$V_- = V_+ \tag{2}$$

$$I_{R_3} = \frac{V_-}{R_3} = \frac{V_+}{R_3} \tag{3}$$

$$I_{R_4} = I_{R_3} \tag{4}$$

$$V_o = V_+ + R_4 I_{R_4} = V_+ + R_4 I_{R_3} = V_+ + R_4 \cdot \frac{V_+}{R_3} = V_+ \cdot \left(1 + \frac{R_4}{R_3}\right) = V_{in}\frac{sC_2R_2}{1 + sC_2R_2} \cdot \left(1 + \frac{R_4}{R_3}\right) \tag{5}$$

$$\frac{V_o}{V_{in}} = \frac{sC_2R_2}{1 + sC_2R_2}\left(1 + \frac{R_4}{R_3}\right) \tag{6}$$

$$K = C_2R_2 \cdot \left(1 + \frac{R_4}{R_3}\right) \tag{7}$$

$$\omega_1 = \frac{1}{C_2R_2} \tag{8}$$

$$\frac{V_o}{V_{in}} = K\frac{s}{1 + \frac{1}{\omega_1}} \tag{9}$$

$$K|_{dB} = 20\log_{10}|K| = \log_{10}\left|C_2R_2 \cdot \left(1 + \frac{R_4}{R_3}\right)\right| = -19.1722dB \tag{10}$$

$$\log_{10}|\omega_1| = \log_{10}\left|\frac{1}{C_2R_2}\right| = 2.0000 \tag{11}$$

1.1.1 Bode diagram

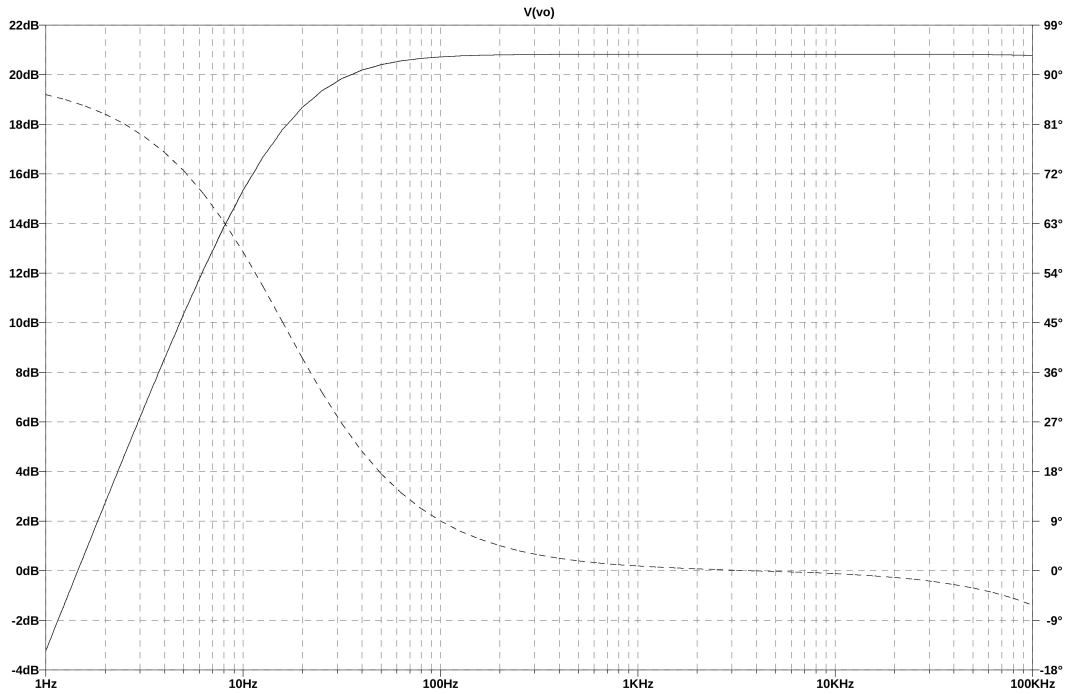

Figure 2: Audio amplifier - Ideal op. amp.

1.2 Voltage output waveform - LT1028 op. amp.

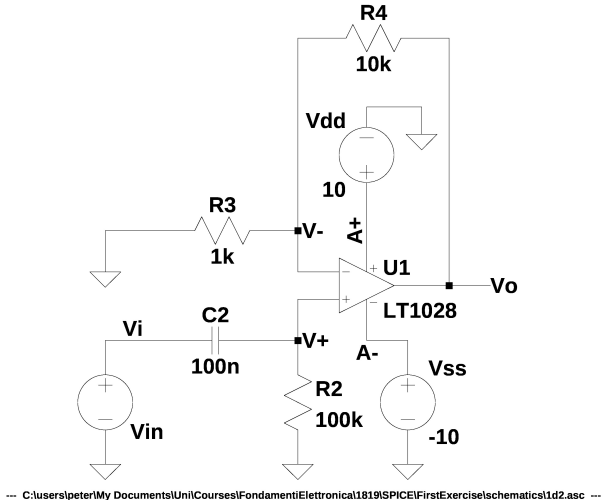

Figure 3: Audio amplifier - LT1028 op. amp.

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 Vi V+ 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

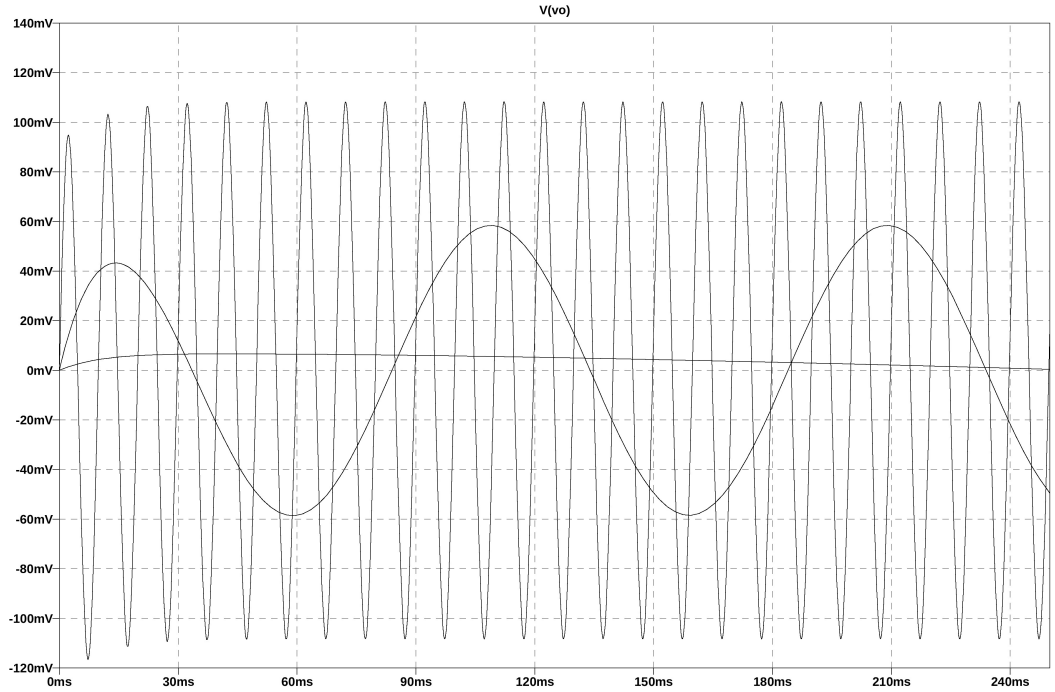

Figure 4: Audio Amplifier - Voltage output waveform

1.3 Bode diagram - LT1028 op. amp.

1.3.1 Netlist

```
* Audio Amplifier - Bode diagram
********************************************************************************
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* Resistances
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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

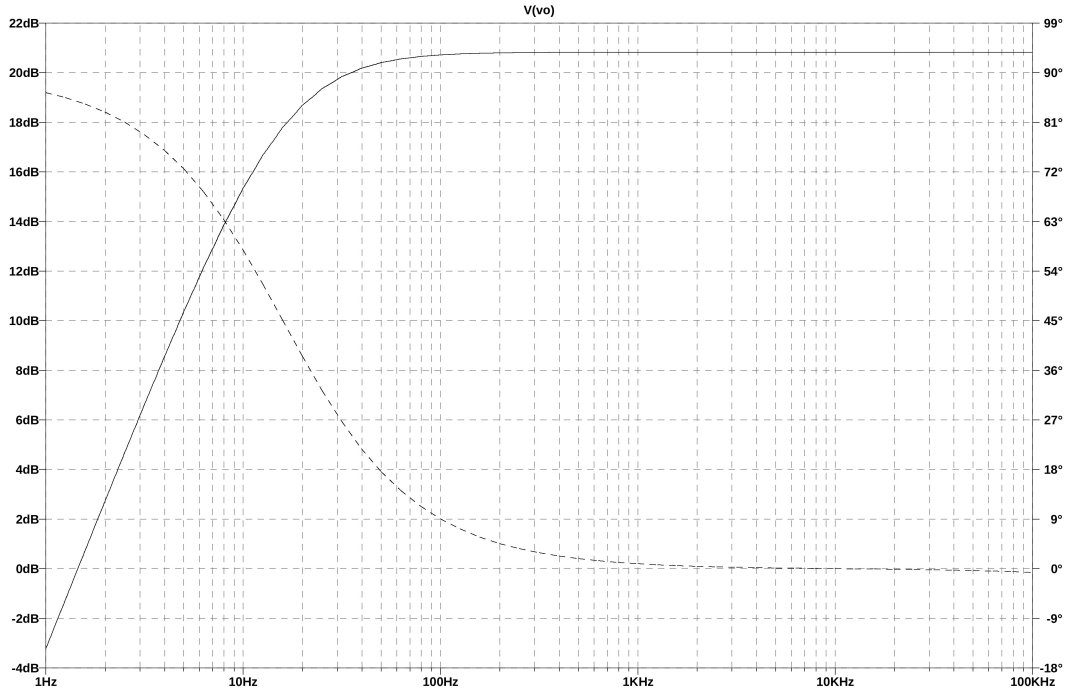

Figure 5: Audio Amplifier - Bode diagram