Diode

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CO-526-B - Electronics Lab

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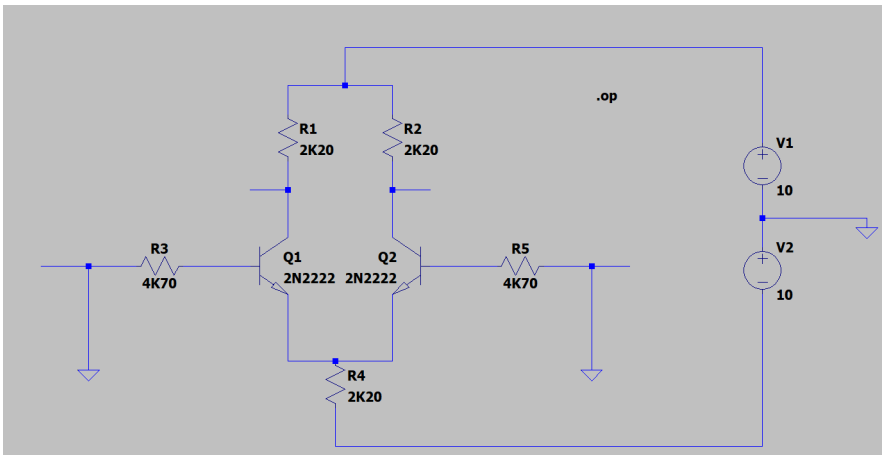
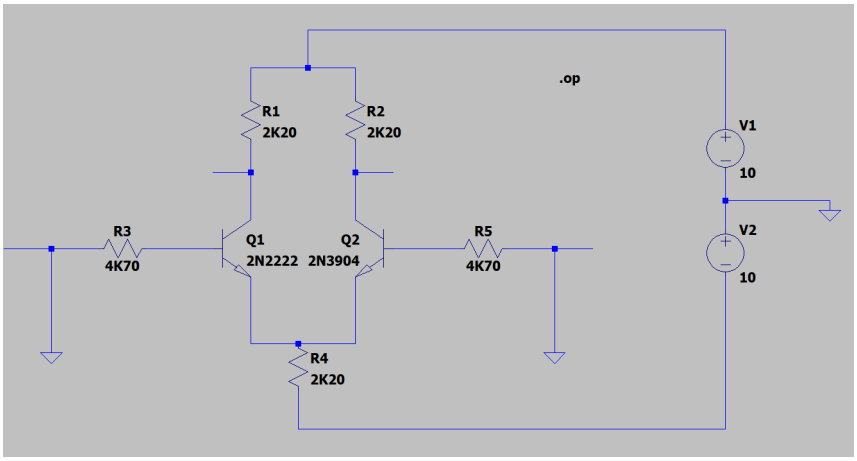
1 Introduction - Prelab

1.1 Simulation of a Differential Amplifier

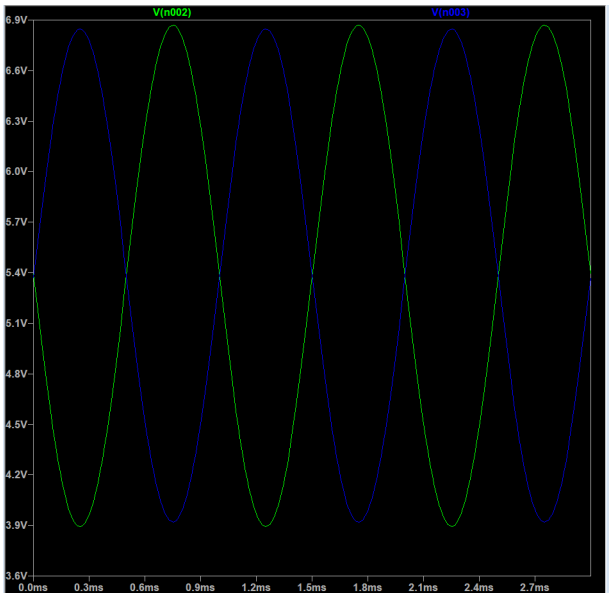
1. 

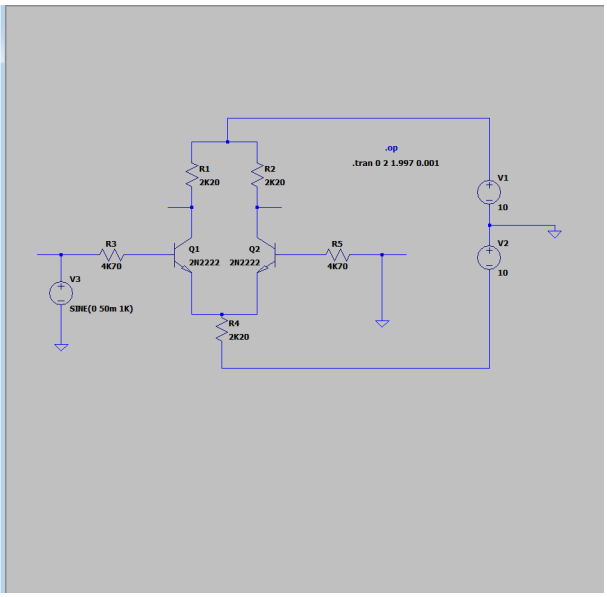
Measured voltages and currents:
V_{BE} = -47.09 - (-720.71) = 767.8mV, V_C = 5.382V, I_C = 2.099mA, I_E = 2.109mA, I_{RE} = 4.219mA.



By changing one transistor the V_{BE}, V_C, I_C, I_E values are not symmetric anymore (ex.: V_C(Q1) = 5.911V, V_C(Q2) = 4.837V), therefore the circuit cannot work properly.

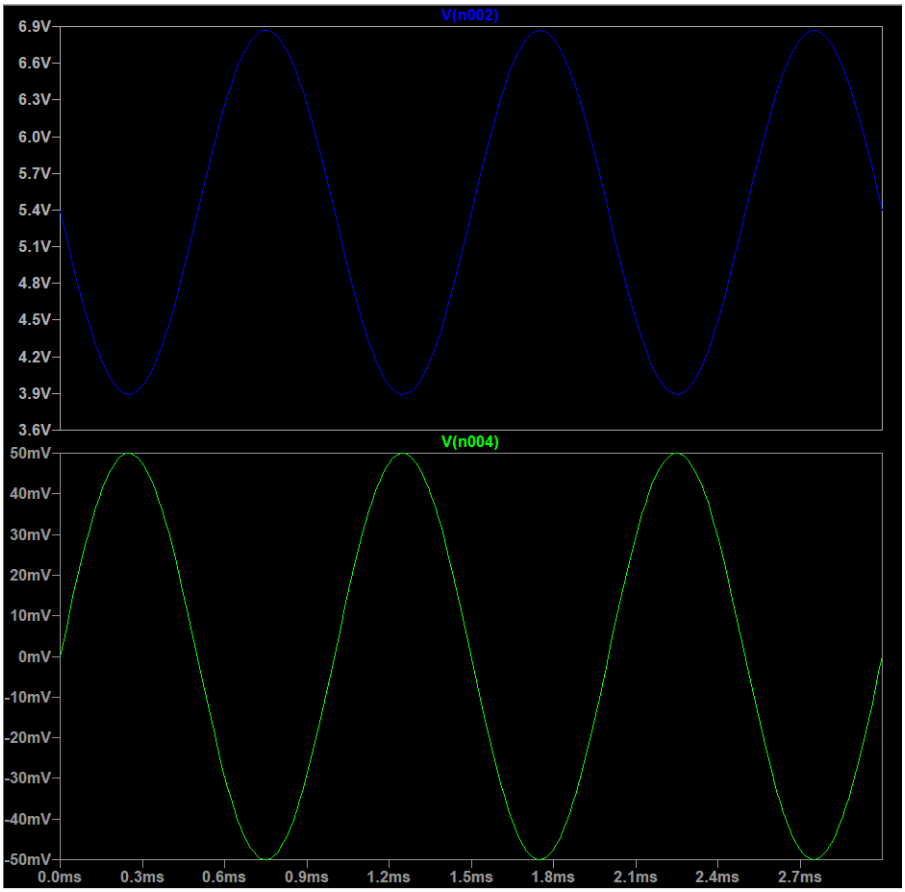
2. **Single ended input analysis**





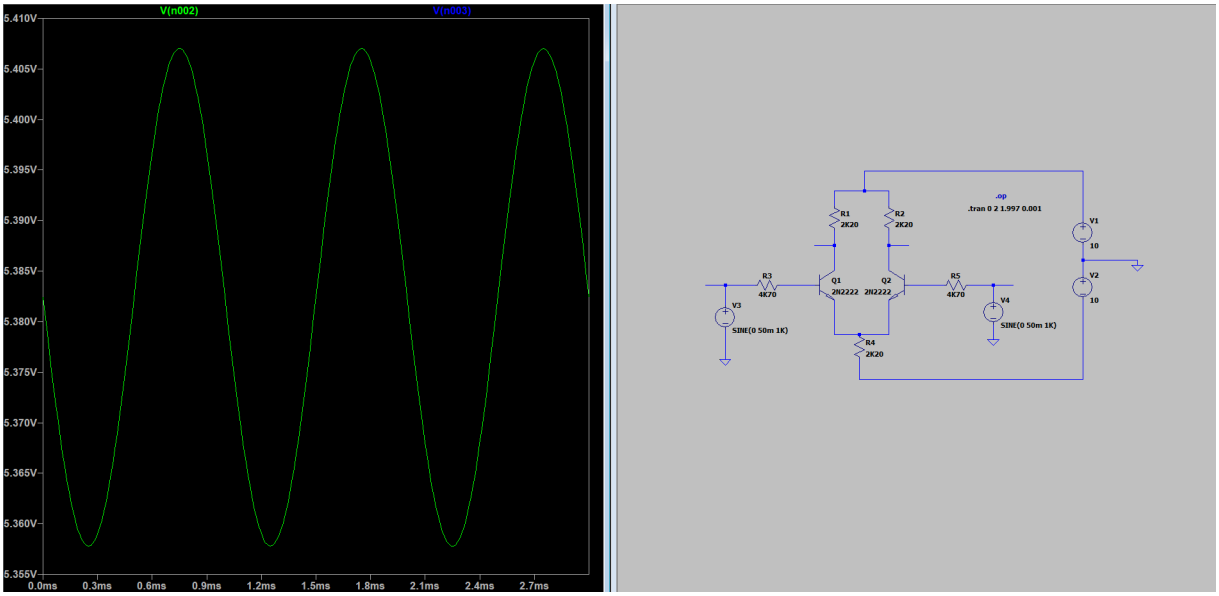
Green line: V_C(Q1), blue line: V_C(Q2). (peak to peak: 2.923V)

To calculate A_{Vdiff} I need V_{od} and V_{id}.

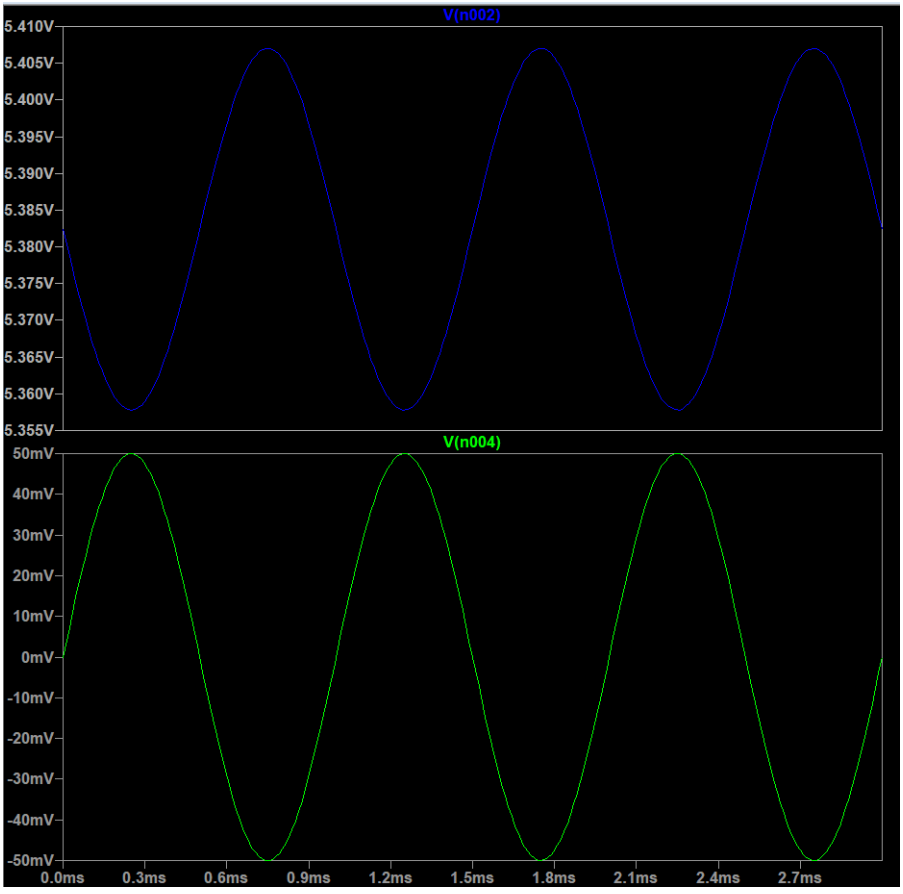


Top pane: V_{o1}, bottom pane: V_{i1}
$V_{id} = V_{i1} - V_{i2} = 100\text{mV}$ peak to peak
$V_{od} = V_{o1} = 3\text{V}$ peak to peak
$A_{Vdiff} = 20log(\frac{V_{od}}{V_{id}}) = 29.5$ dB.

3. **Common mode input analysis**



V_C(Q1) and V_C(Q2) are overlapping. (peak to peak: 49.17mV).
To calculate A_{Vcm} I need V_{oc} and V_{ic}.



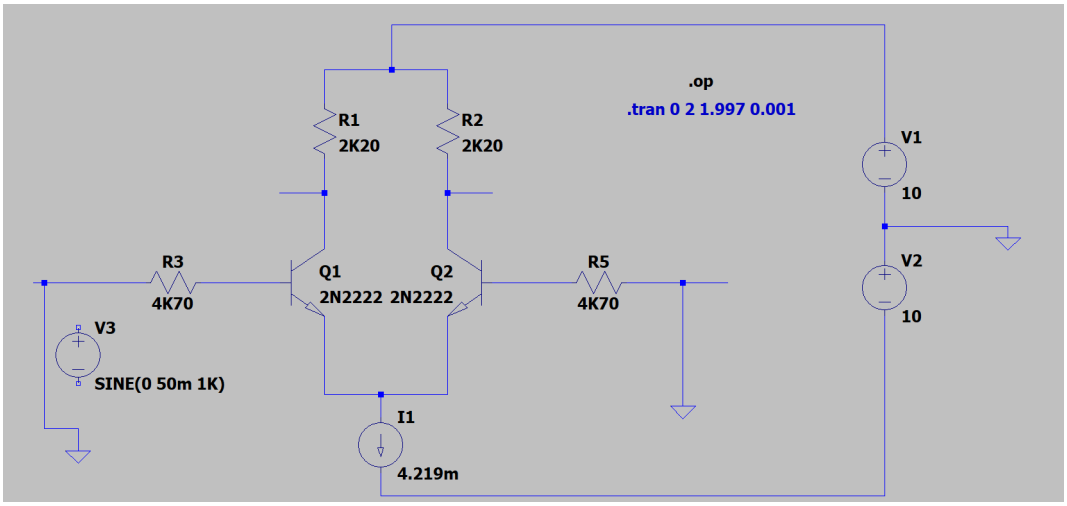
Top pane: V_{o1}, bottom pane: V_{i1}

$V_{ic} = (V_{i1} + V_{i2})/2 = 100$mV peak to peak
$V_{oc} = V_{o1} = 49.18$mV peak to peak
$A_{Vcm} = 20log(\frac{V_{oc}}{V_{ic}})$= -6.16 dB.

4. **Common mode rejection**

$CMRR = 20log(\frac{A_{Vdiff}}{A_{Vcm}})$= 35.7dB.
current source: 4.219 from top to bottom

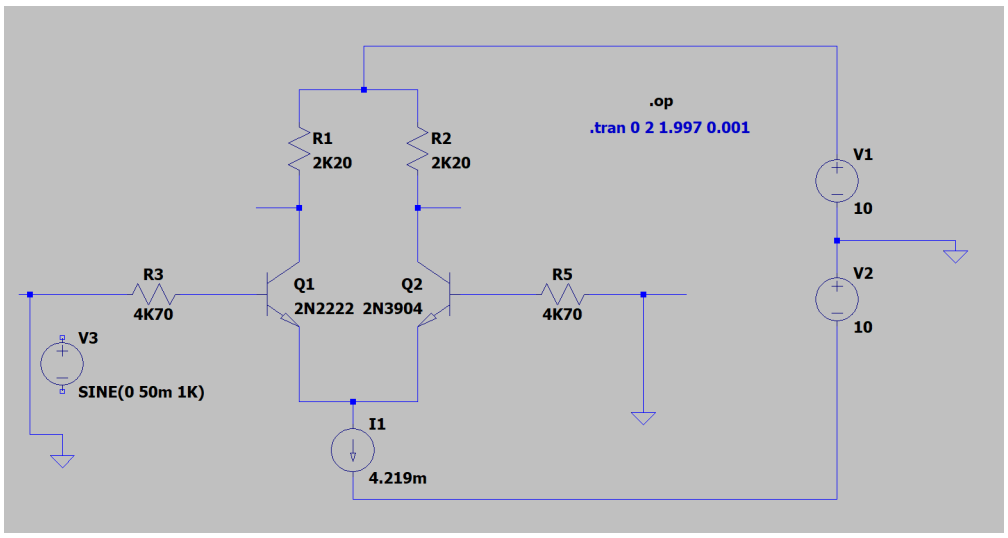
5. **Replacing R4 by equivalent current source**



6. **Analyses using the current source**

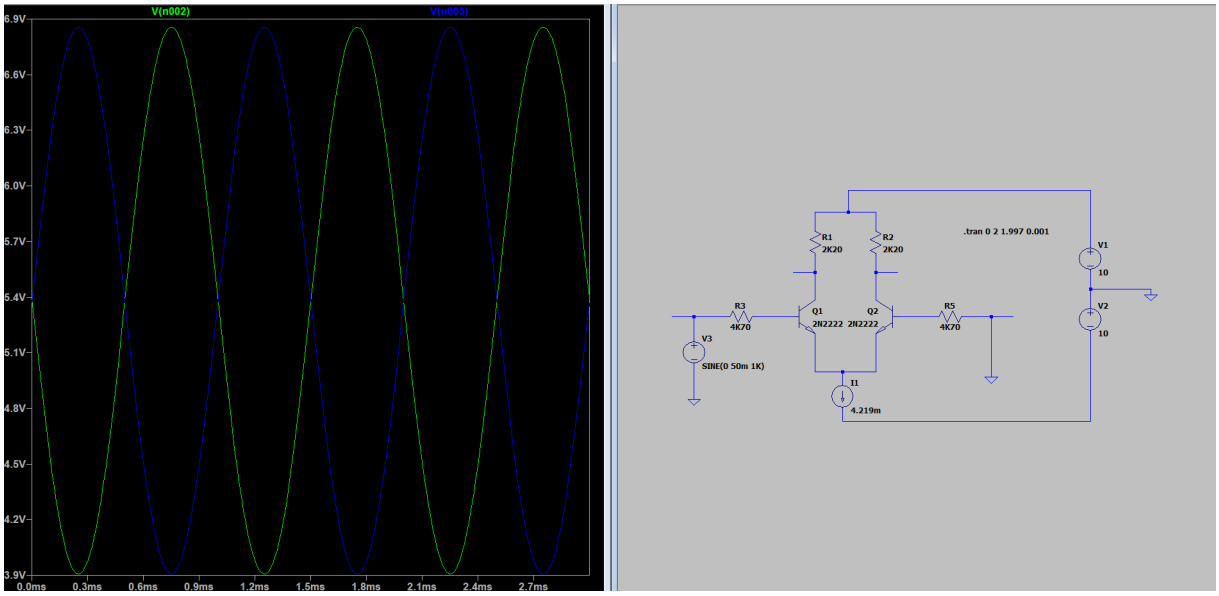
   (a) **DC operation point analysis**

V_{BE} = -47.11 - (-720.74) = 767.85mV, V_C = 5.381V, I_C = 2.099mA, I_E = 2.109mA, I_{RE} = 4.219mA. (current source)



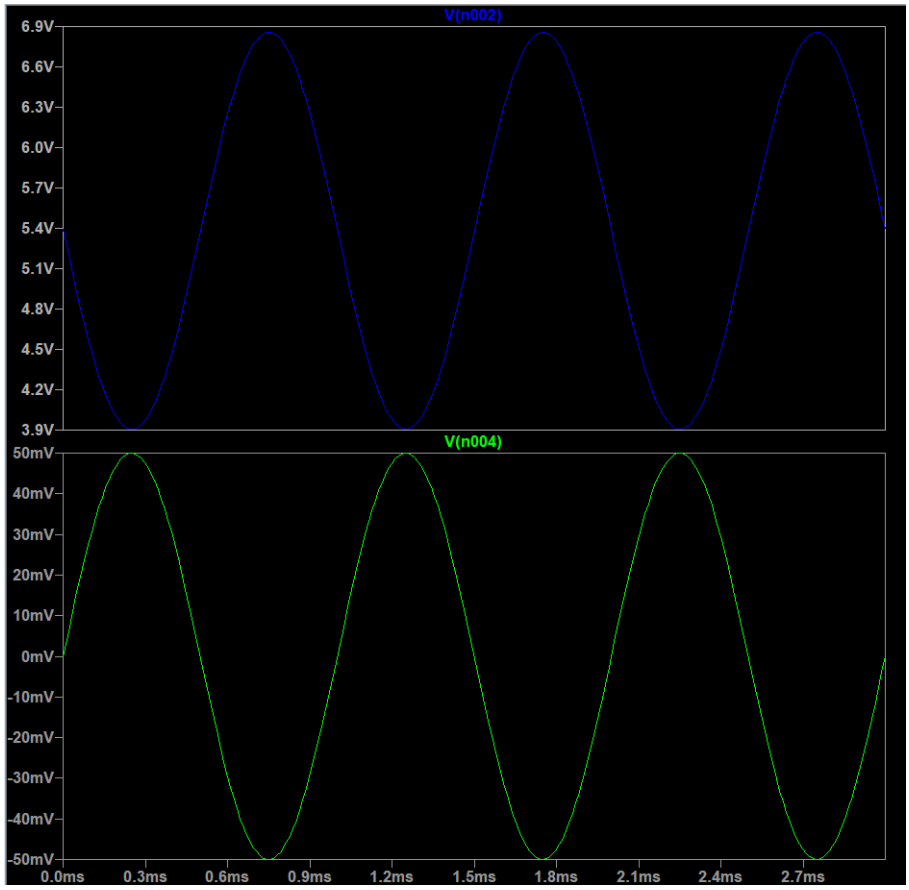
By changing one transistor the V_{BE}, V_C, I_C, I_E values are not symmetric anymore (ex.: V_C(Q1) = 5.913V, V_C(Q2) = 4.841V), therefore the circuit cannot work properly.

(b) **Single ended input analysis**



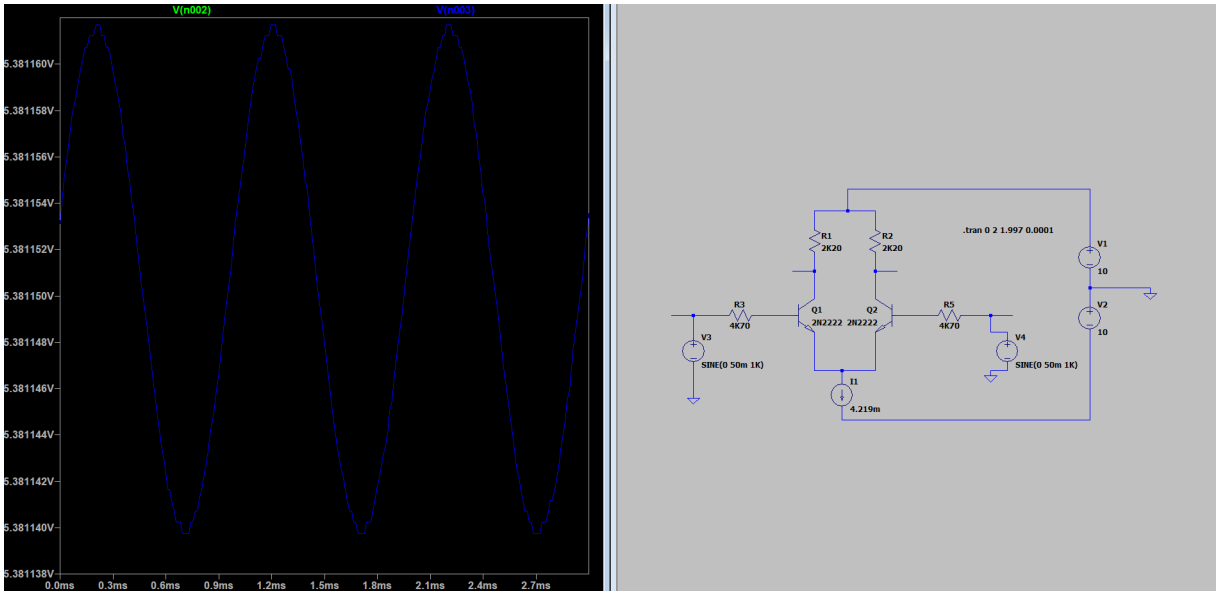
Green line: V_C(Q1), blue line: V_C(Q2). (peak to peak: 2.95V)

To calculate A_{Vdiff} I need V_{od} and V_{id}.



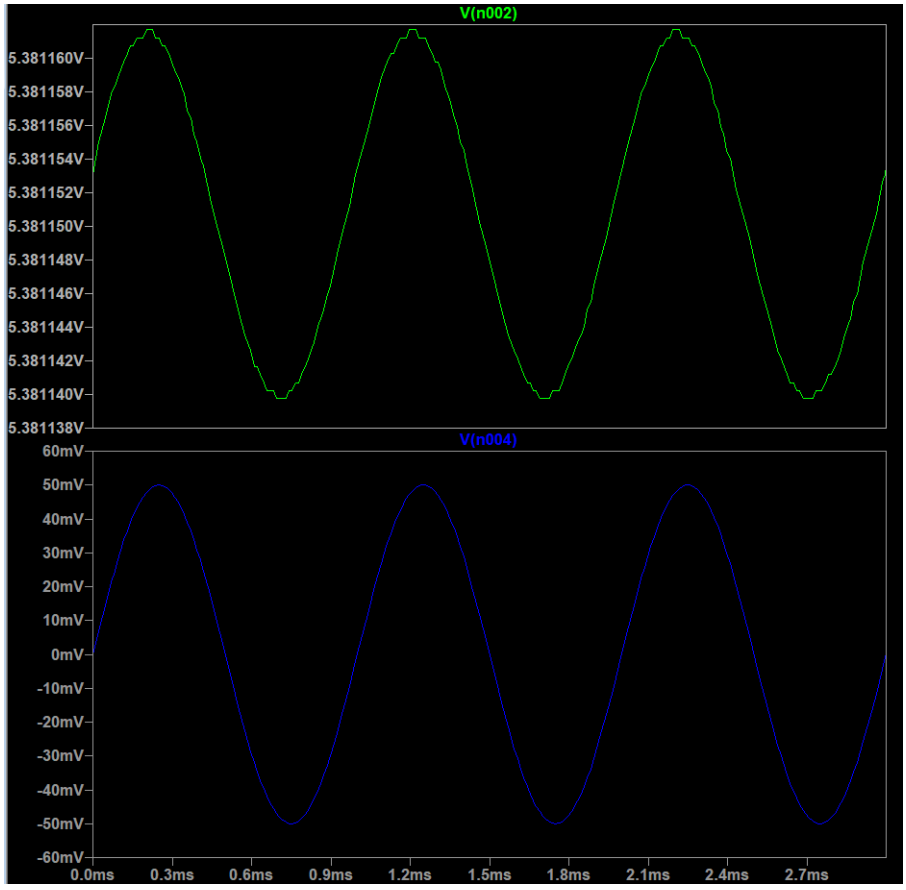
Top pane: V_{o1}, bottom pane: V_{i1}
$V_{id} = V_{i1} - V_{i2} = 100$mV peak to peak
$V_{od} = V_{o1} = 2.95$V peak to peak
$A_{Vdiff} = 20log(\frac{V_{od}}{V_{id}})= 29.4$ dB.

(c) **Common mode input analysis**



V_C(Q1) and V_C(Q2) are overlapping. (peak to peak: 21.93μV).

To calculate A_{Vcm} I need V_{oc} and V_{ic}.



Top pane: V_{o1}, bottom pane: V_{i1}

$V_{ic} = (V_{i1} + V_{i2})/2 = 100$mV peak to peak
$V_{oc} = V_{o1} = 21.93\mu$V peak to peak
$A_{Vcm} = 20log(\frac{V_{oc}}{V_{ic}})$= -73.28 dB.

(d) **Common mode rejection**

$CMRR = 20log(\frac{A_{Vdiff}}{A_Vcm})$= 102.6dB.