CET 323 LAB — Name: Van Nguyen

Dr. Park — Date: October 20th, 2020.

Class: CET 323_01

LAB_05

Differential Amplifiers

Reading

Floyd, Electronic Devices, Ninth Edition, Chapter 10.

Key Objectives

Part 1 : Construct and test a discrete differential Amplifiers with current-source biasing ➔ Multisim Simulation.

Components needed

Part 1 : The differential Amplifiers.

Resistor : Two 100 Ω , one 4.7 kΩ , three 10 kΩ , one 33 kΩ , two 100 kΩ .

Transistors : three **2N3904**

Capacitors : Two 10 μF.

Part 1 : The differential Amplifiers.

1. Measure and record the values of the resistors listed in the Table 12-2. Best result can be obtained if R_{B1} and R_{B2} are matched.

Table 12_1

Resistors	Listed Value	Measured Value
R_{B1}	100 kΩ	
R_{B2}	100 kΩ	
R_{E1}	100 Ω	
R_{E2}	100 Ω	
R_T	10 kΩ	
R_{C2}	10 kΩ	

Table 12_2

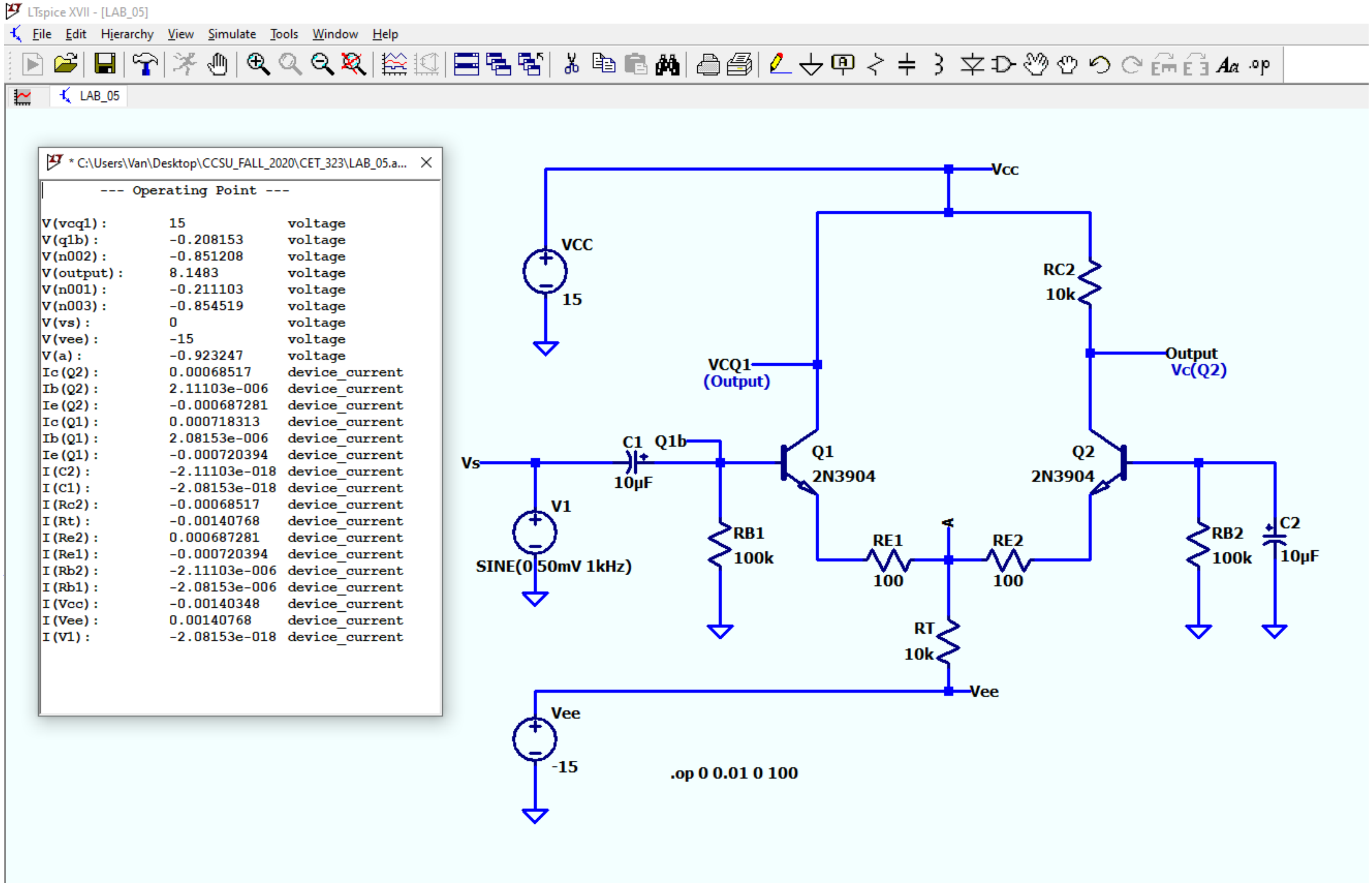
DC Parameter	Computed Value	Measured Value
V_A	- 1 V	- 0.92 V
I_T		-1.4 mA
$I_{E1} = I_{E2}$		- 708 µA
$V_{C(Q1)}$		15 V
$V_{C(Q2)}$		8.148

1)- The value measured to obtain from the LTSpice simulation of Figure 12_1

Since both collector currents have $V_{C(Q1)}$ and $V_{C(Q2)}$ as output and

IF both collector resistances are equal (when the input voltage ($V_{S(off)}$) is 0) then $V_{C(Q1)} = V_{C(Q2)}$

BUT at the output of Q_1 there is no resistor R_{C1}, so $V_{C(Q1)} = V_{CC} = 15$ V and $V_{C(Q2)} = V_{out}$



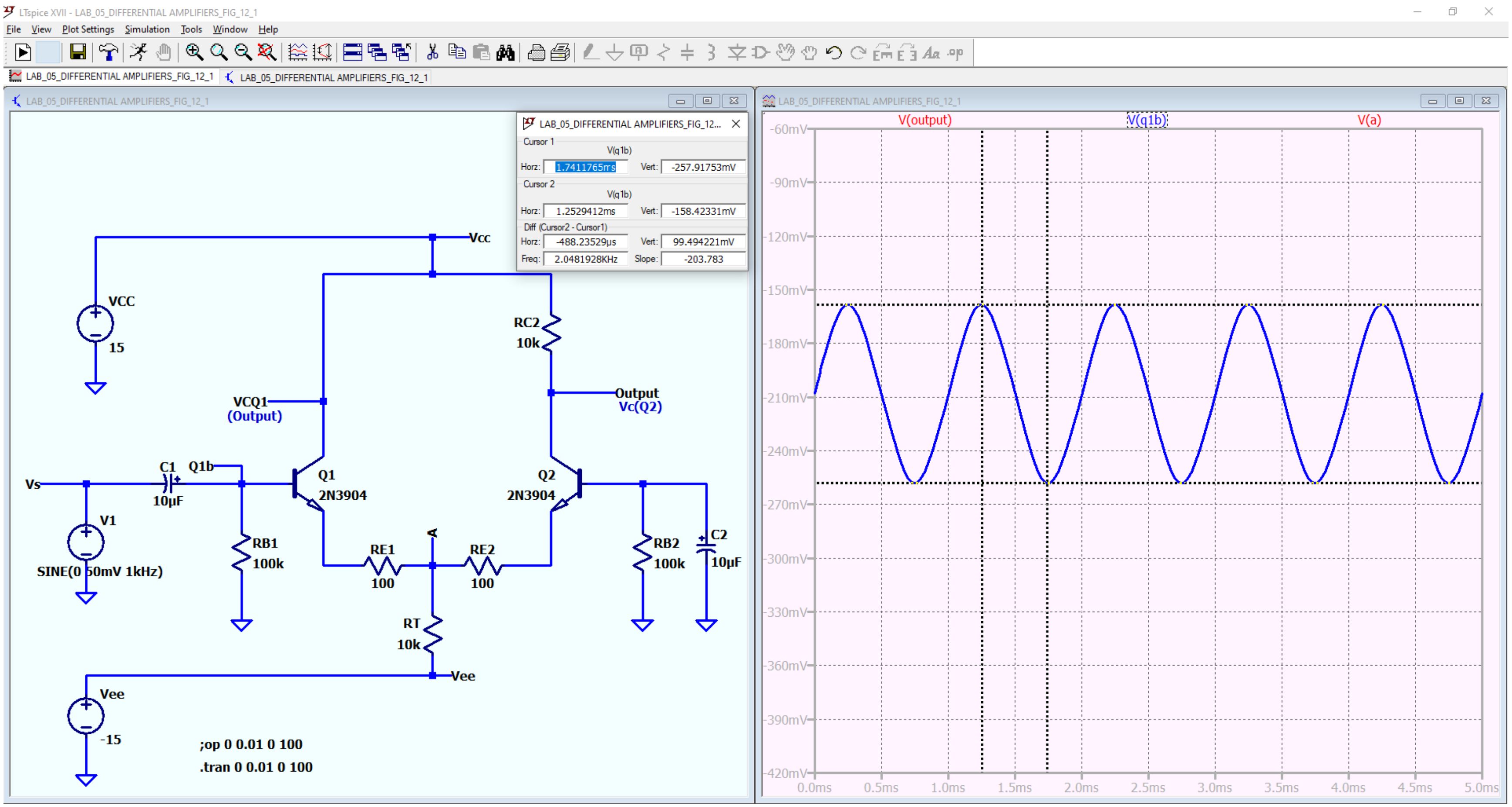
LTspice XVII - [LAB_05]
File Edit Hierarchy View Simulate Tools Window Help
LAB_05
* C:\Users\Van\Desktop\CCSU_FALL_2020\CET_323\LAB_05.a...
--- Operating Point ---
V(vcq1): 15 voltage
V(q1b): -0.208153 voltage
V(n002): -0.851208 voltage
V(output): 8.1483 voltage
V(n001): -0.211103 voltage
V(n003): -0.854519 voltage
V(vs): 0 voltage
V(vee): -15 voltage
V(a): -0.923247 voltage
Ic(Q2): 0.00068517 device_current
Ib(Q2): 2.11103e-006 device_current
Ie(Q2): -0.000687281 device_current
Ic(Q1): 0.000718313 device_current
Ib(Q1): 2.08153e-006 device_current
Ie(Q1): -0.000720394 device_current
I(C2): -2.11103e-018 device_current
I(C1): -2.08153e-018 device_current
I(Rc2): -0.00068517 device_current
I(Rt): -0.00140768 device_current
I(Re2): 0.000687281 device_current
I(Re1): -0.000720394 device_current
I(Rb2): -2.11103e-006 device_current
I(Rb1): -2.08153e-006 device_current
I(Vcc): -0.00140348 device_current
I(Vee): 0.00140768 device_current
I(V1): -2.08153e-018 device_current
Vcc
VCC
15
RC2
10k
Output
Vc(Q2)
VCQ1
(Output)
C1
Q1b
10µF
Vs
Q1
2N3904
Q2
2N3904
V1
SINE(0 50mV 1kHz)
RB1
100k
RE1
100
RE2
100
RB2
100k
C2
10µF
RT
10k
Vee
-15
.op 0 0.01 0 100

II/- Compute and record the ac parameters given in Table 12_3

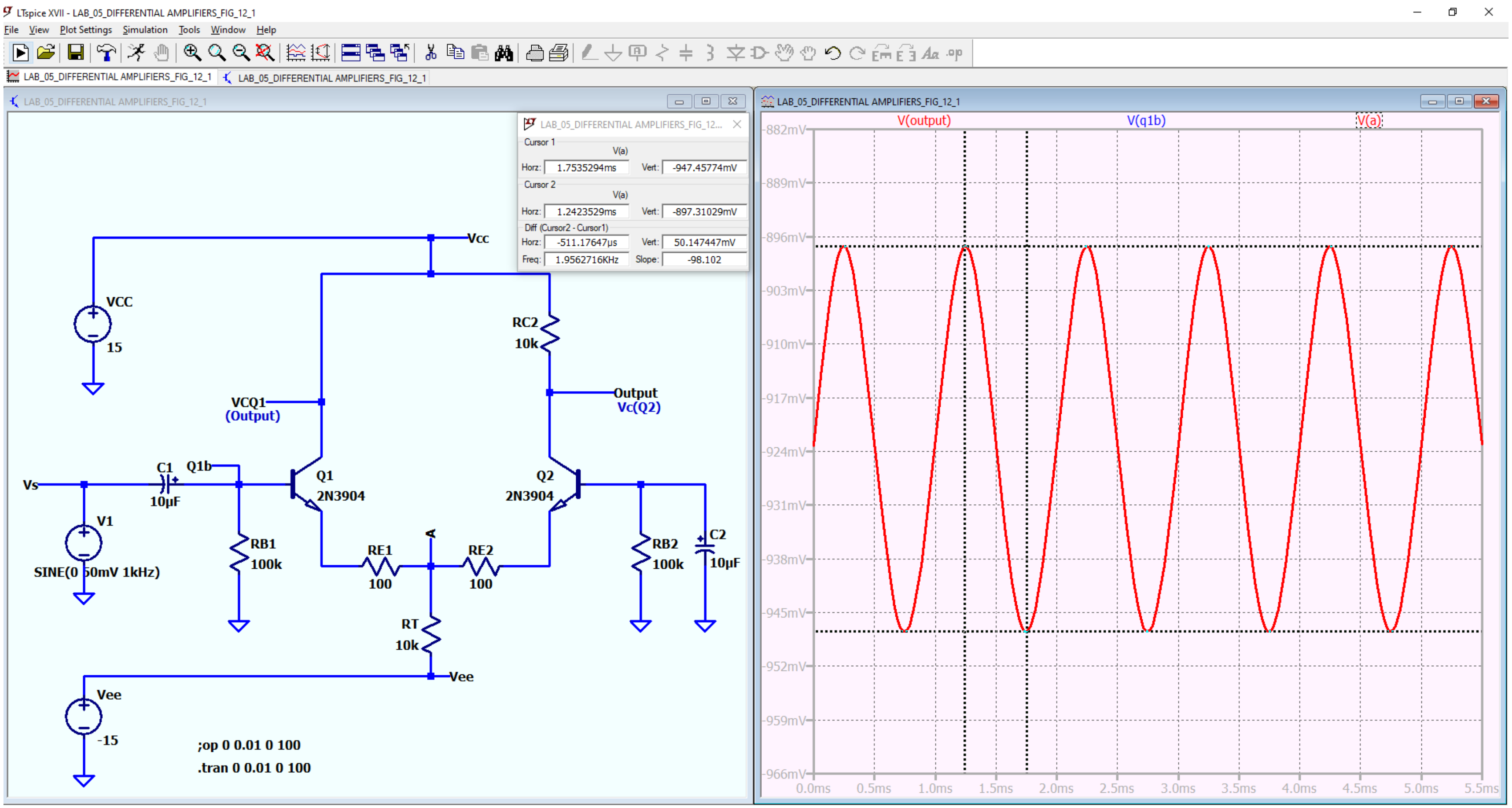
Table 12_3

AC Parameter	Computed Value	Measured Value
$V_{b(Q1)}$	100 mV_{pp}	**99.49 mV**
V_A		**50.15 mV**
$R_{e(Q1)} = r_{e(Q2)}$		
$A_{V(d)}$		**35.2**
V_{cQ2} (output)		**3.5 V**
$R_{in(tot)}$		
$A_{C(cm)}$		**0.487**
CMRR’		**37.18 dB**

1) Measured Value $V_{b(Q1)}$ = **99.49 mV**

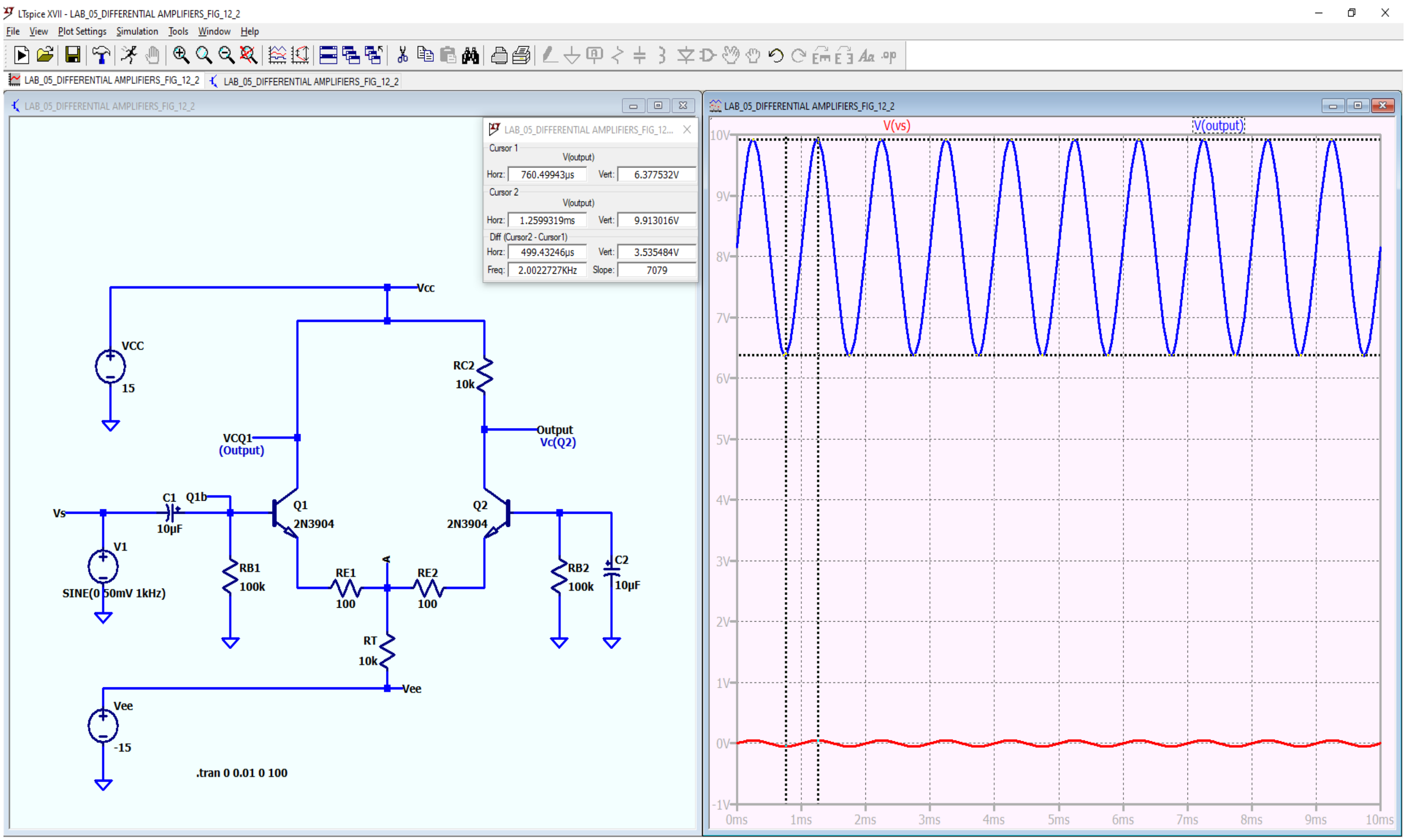


2) Measured Value V_A = **50.15 mV**



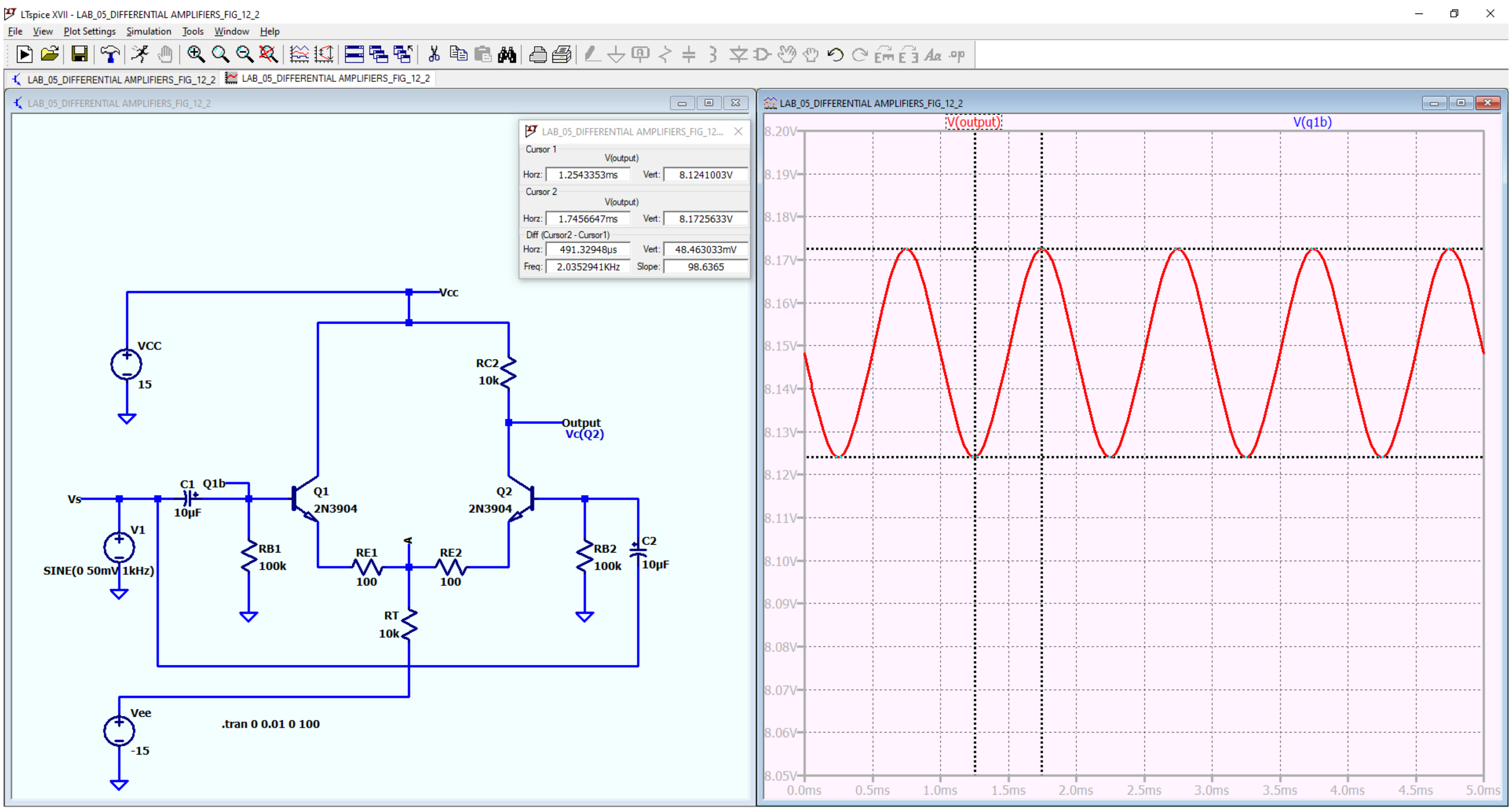
3) Computed Value $A_{V(d)} = \dfrac{V_{out}}{V_{in}} = \dfrac{V_{out}}{V_{b(Q1)}} = \dfrac{3\,500\ mV}{99.49\ mV} = \mathbf{35.2}$

❖ Measured Value V_{out} = 3.5 V

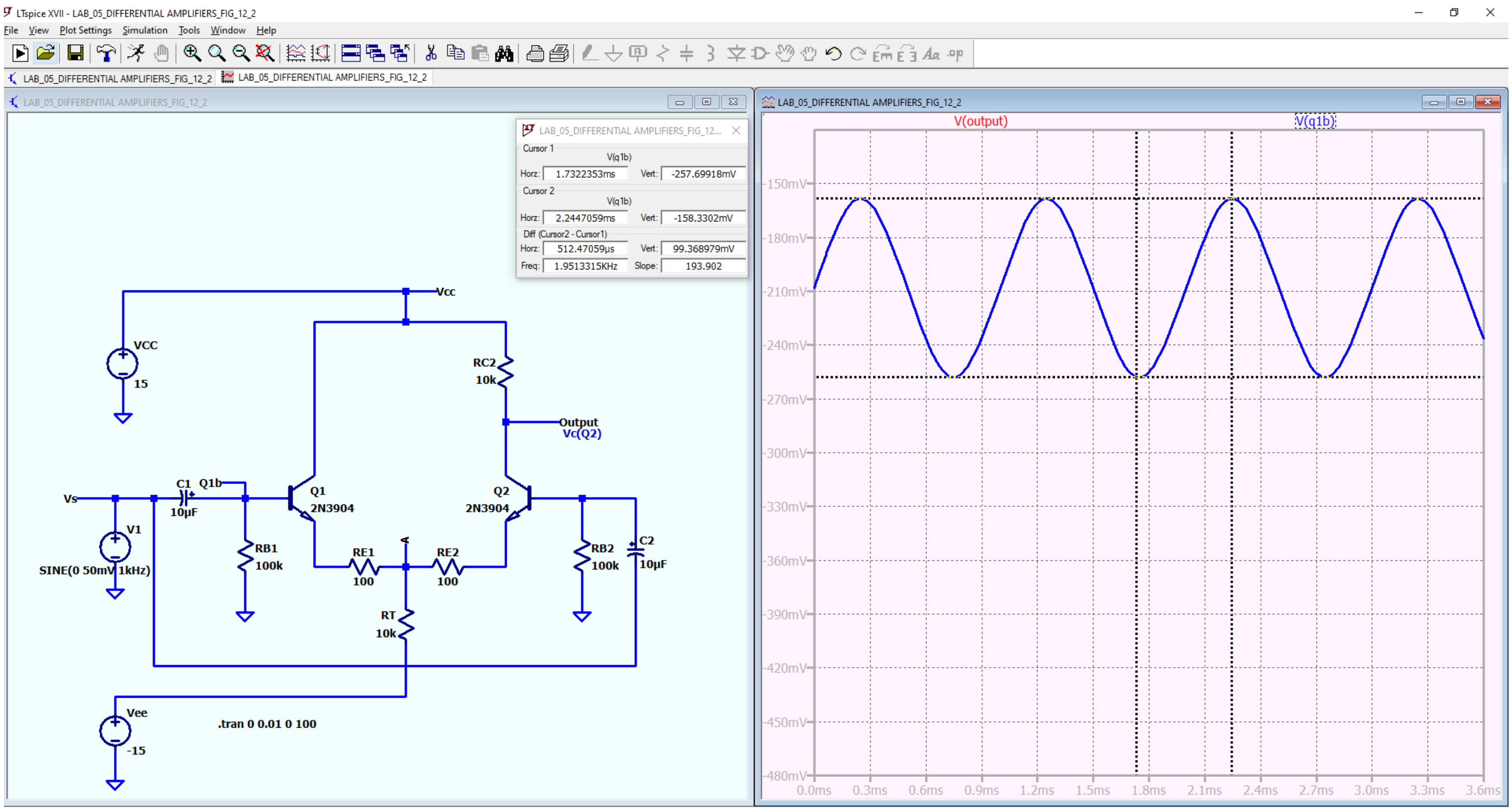


4) Computed Value $A_{V(d)} = \frac{V_{out}}{V_{in}} = \frac{V_{out}}{V_{b(Q1)}} = \frac{48.5\ mV}{99.4\ mV} = 0.487$

- Measured Value V_{out} = 48.5 mV



- Measured Value $V_{b(Q1)}$ = 99.4 mV



1. CMRR' is the decibel common-mode rejection ratio (indicated with the prime symbol). It is 20 times the Logarithmic ratio of absolute value of the ratio of $A_{v(d)}$ to $A_{v(cm)}$, expressed in dB. In equation, this is

$$\boxed{CMRR' = 20log\frac{|A_{v(d)}|}{|A_{v(cm)}|}}$$

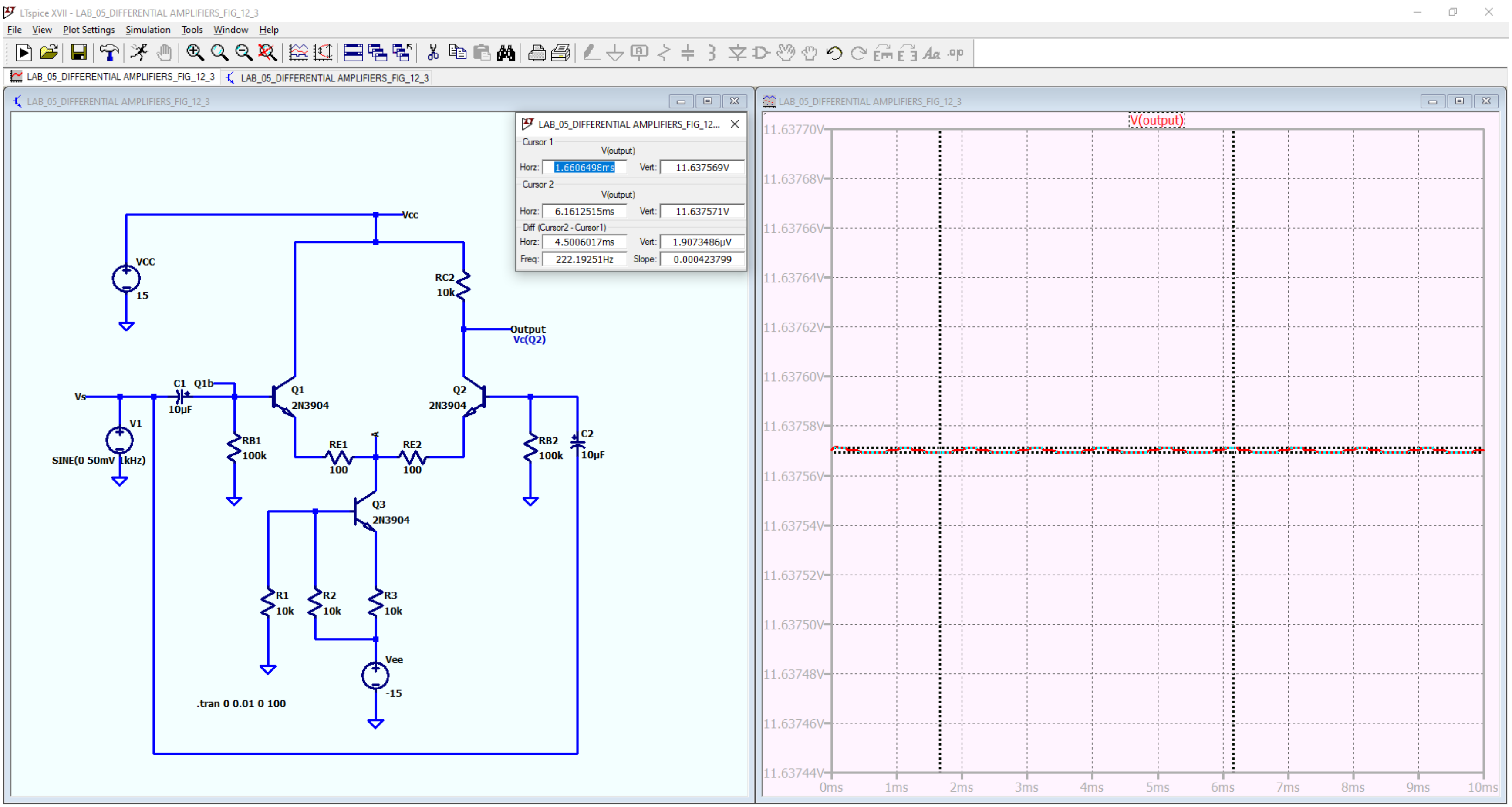
$$CMRR' = 20log\frac{|A_{v(d)}|}{|A_{v(cm)}|} = 20\log\frac{35.2}{0.487} = 37.18\ dB$$

⇨ $\boxed{\text{CMRR} = 37.18 \text{ dB}}$

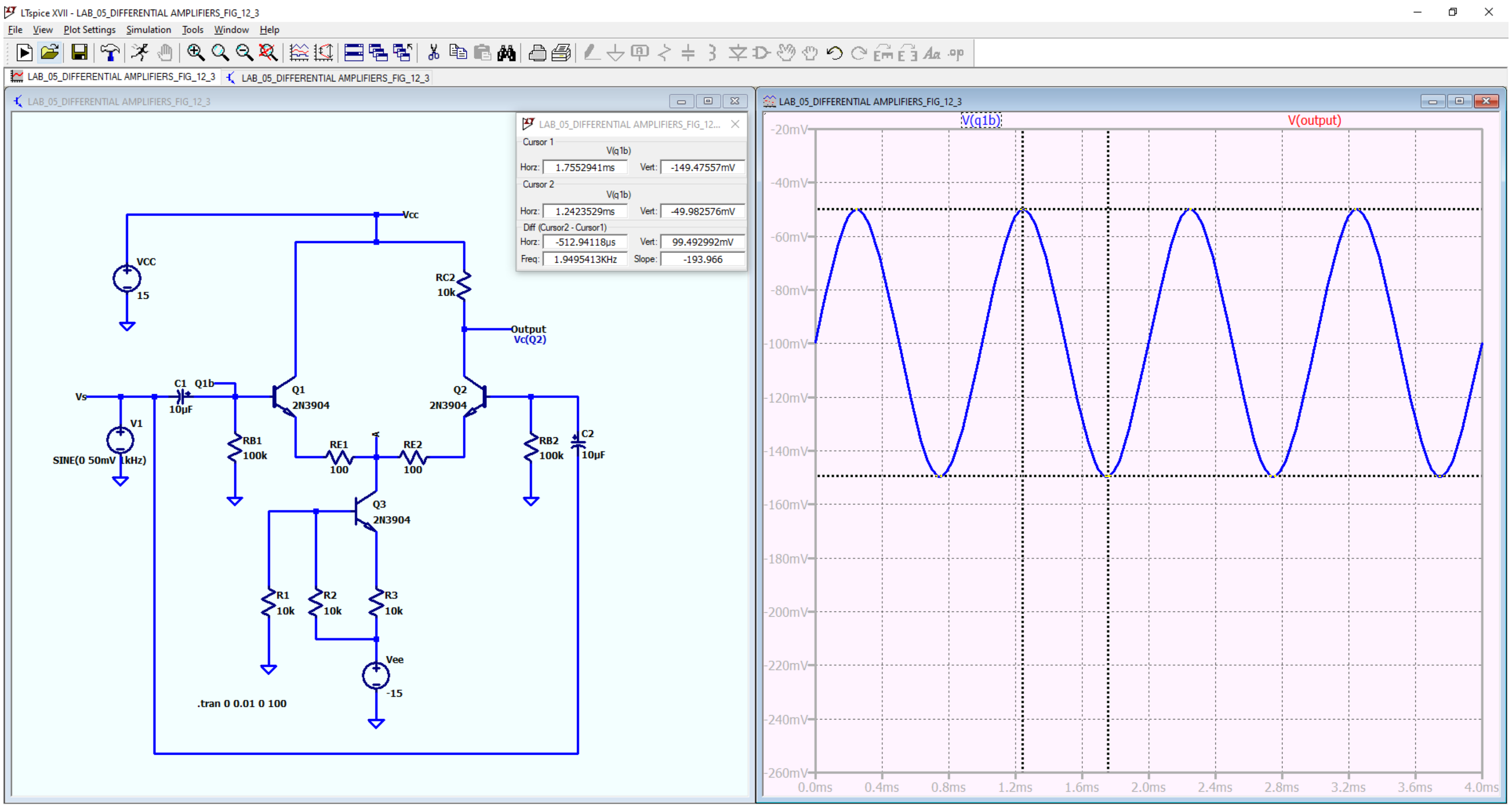
9. Measure the common-mode gain with the constant- current source. Observation

5) Computed Value $A_{V(d)} = \frac{V_{out}}{V_{in}} = \frac{V_{out}}{V_{b(Q1)}} = \frac{1.9\ \mu V}{99.5\ \mu V} = 0.019$

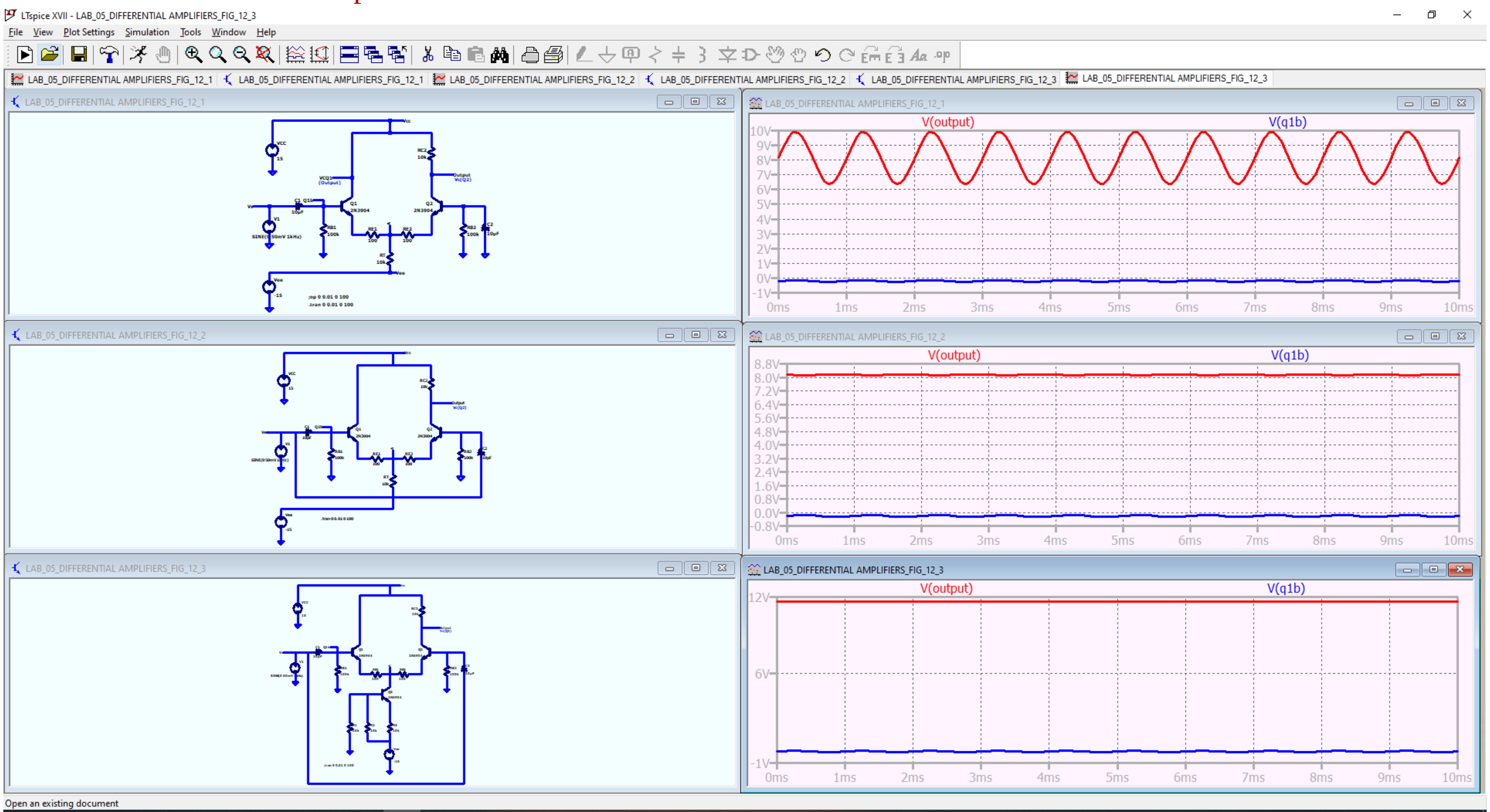
- Measured Value $V_{out} = 1.9\ \mu V$



- Measured Value $V_{b(Q1)}$ = **99.5 μV**



✓ Observation and Compare



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