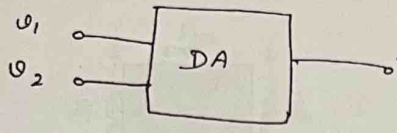
Differential Amplifier



$$v_o = A_{v_o}(v_1 - v_2).$$

where A_{vo} is called open loop gain

We define the differential mode input voltage as

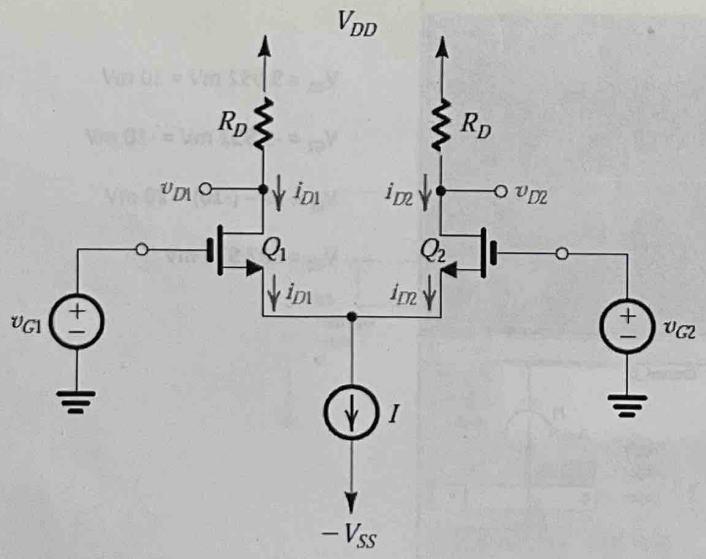
$$v_d = v_1 - v_2$$

and common mode input voltage as

$$v_{cm} = \frac{v_1 + v_2}{2}.$$

$$\boxed{V_o = A_d v_d + A_{cm} v_{cm}}$$

Differential Mode



Output:

Single ended output = $V_{D2} = V_{od}$

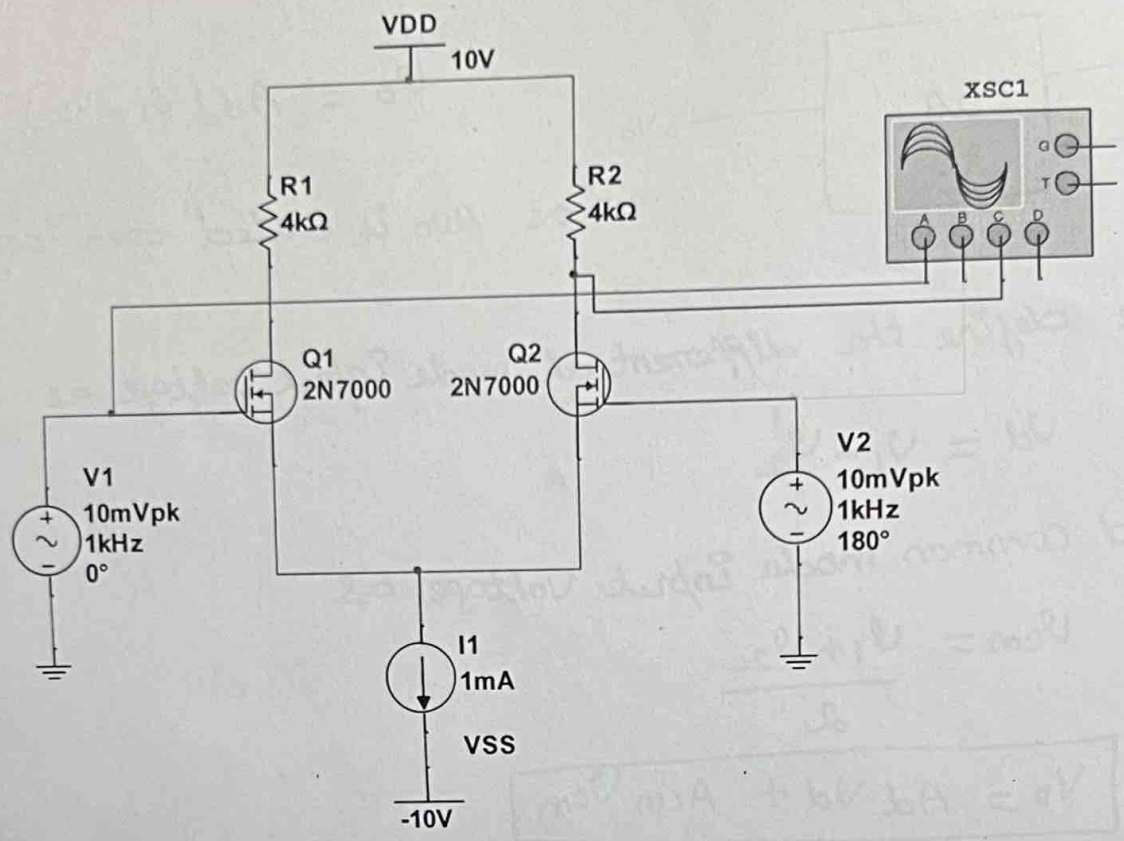
Double ended output = V_{D1}-V_{D2} = V_{od}

Input = $V_{G1} - V_{G2} = V_{id}$

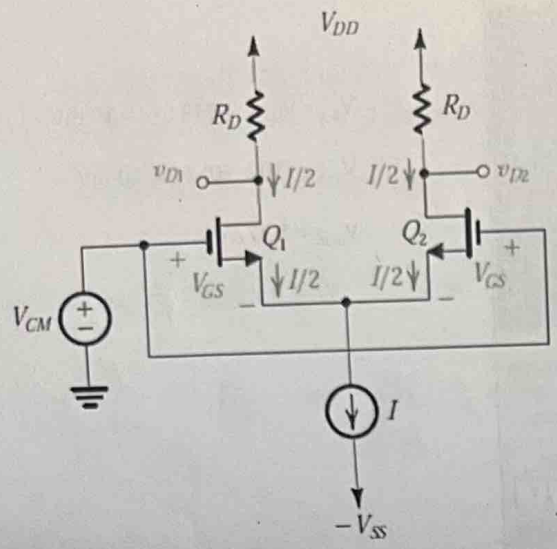
A_d = Differential mode gain

$A_d = V_{od} / V_{id}$

Differential Mode



Common mode operation



Output:

Single ended output = $V_{D2} = V_{out}$

Double ended output = $V_{D1} - V_{D2} = V_{out}$

Input = $(V_{G1} + V_{G2})/2 = V_{cm}$

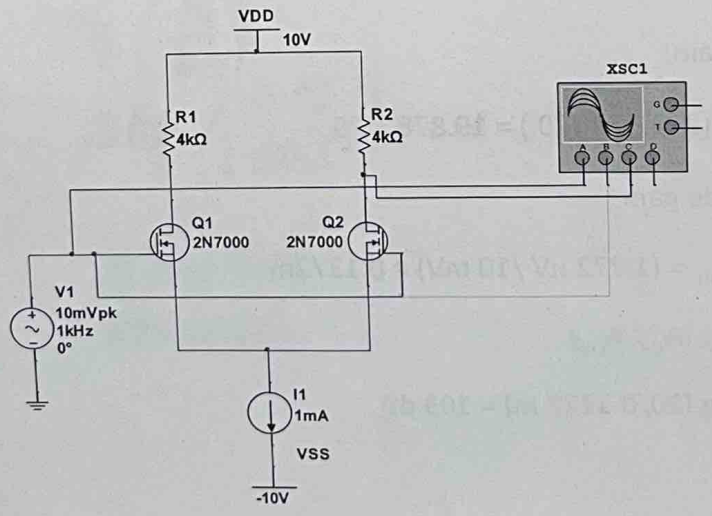
A_{cm} = Common mode gain

$A_{cm} = V_{out} / V_{cm}$

Common Mode Rejection Ratio

CMRR = $20 \log|A_d/A_{cm}|$ dB

Common Mode Response



Task 4

- Design a differential amplifier with a load resistance of 10k, constant current source of 2 mA and supply voltage of ±15V.
- Determine the A_d, A_{cm} and CMRR.

Sol:

$V_{od} = 358.4\,mV$, $V_1 = 10\,mV$

$\therefore A_d = \frac{V_{od}}{2V_1} = \frac{358.4}{20}$

$= 17.92$

$V_{OCM} = 3.209\,\mu V$

$= 0.003209\,mV$

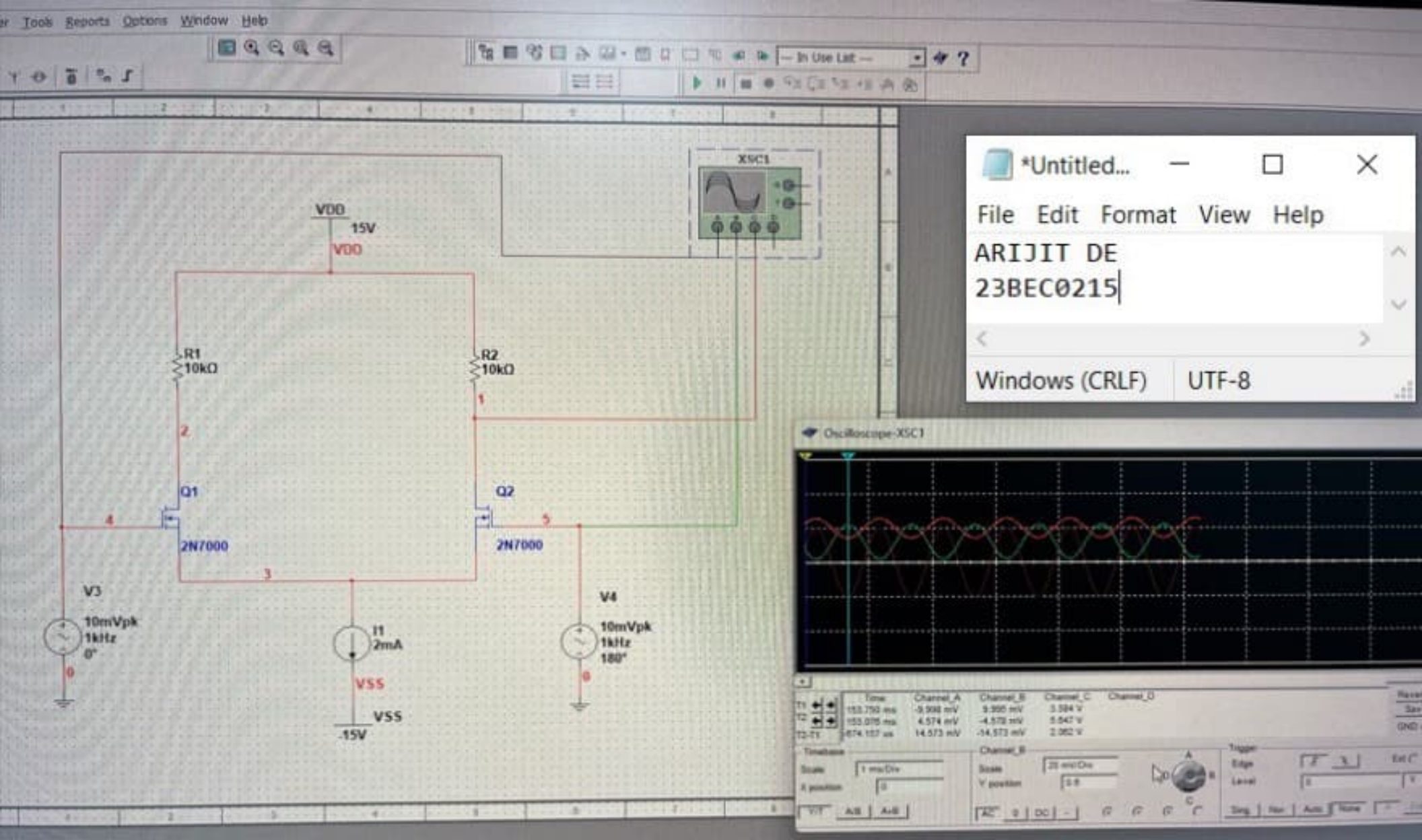
$A_{CM} = \frac{0.003209}{10} = 0.0003209$

$\therefore CMRR = 20\log\left(\frac{A_d}{A_{CM}}\right)$

$= 20\log\left(\frac{17.92}{0.0003209}\right)$

$= 20 \times 4.747$

$= 94.94\,dB$


Tools Reports Options Window Help
In Use List
XSC1
VDD
15V
VDD
R1
10kΩ
R2
10kΩ
1
2
Q1
Q2
4
5
2N7000
2N7000
3
V3
10mVpk
1kHz
0°
0
I1
2mA
VSS
VSS
-15V
V4
10mVpk
1kHz
180°
0
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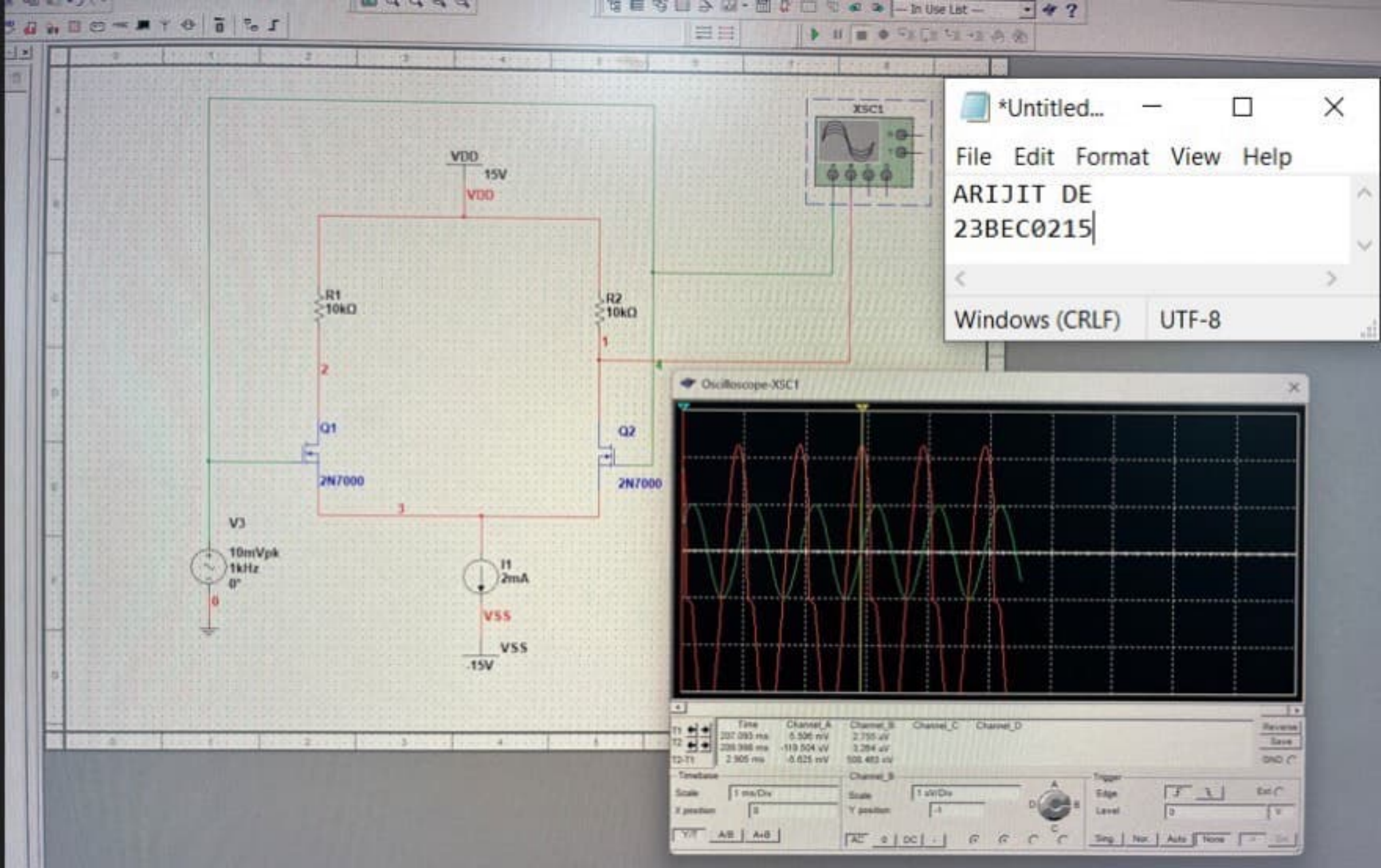
File Edit Format View Help
ARIJIT DE
23BEC0215
Windows (CRLF)
UTF-8
Oscilloscope-XSC1


VDD
15V
VDD
R1
10kΩ
R2
10kΩ
2
1
Q1
Q2
2N7000
2N7000
3
V3
10mVpk
1kHz
0°
0
I1
2mA
VSS
VSS
-15V
XSC1
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File Edit Format View Help
ARIJIT DE
23BEC0215
Windows (CRLF)
UTF-8
Oscilloscope-XSC1