

Lab 2 Solutions

Pre-Lab Work

2.1:

a) $V_{OUT} < V_{IN} - V_{TN}$

b) $V_{OUT} > V_{IN} - V_{TN}$

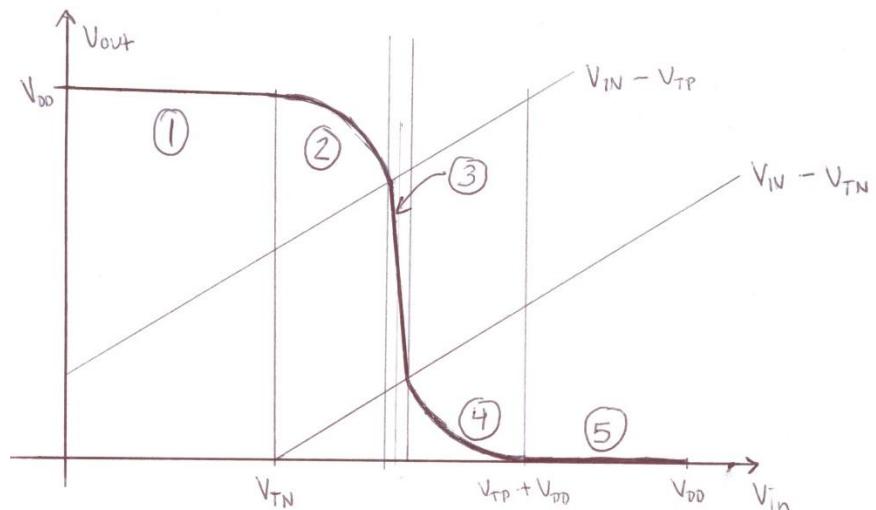
c) $V_{IN} < V_{TN}$

d) $V_{OUT} > V_{IN} - V_{TP}$

e) $V_{OUT} < V_{IN} - V_{TP}$

f) $V_{IN} > V_{TP} + V_{DD}$

g) Here $V_{DD} = 5.0\text{ V}$, $V_{TN} = 1.5\text{ V}$, $V_{TP} = -1.5\text{ V}$, and $k_n = k_p$. With these values I was able to generate the sketch found below (the regions of operation for both FETs are found below as well):

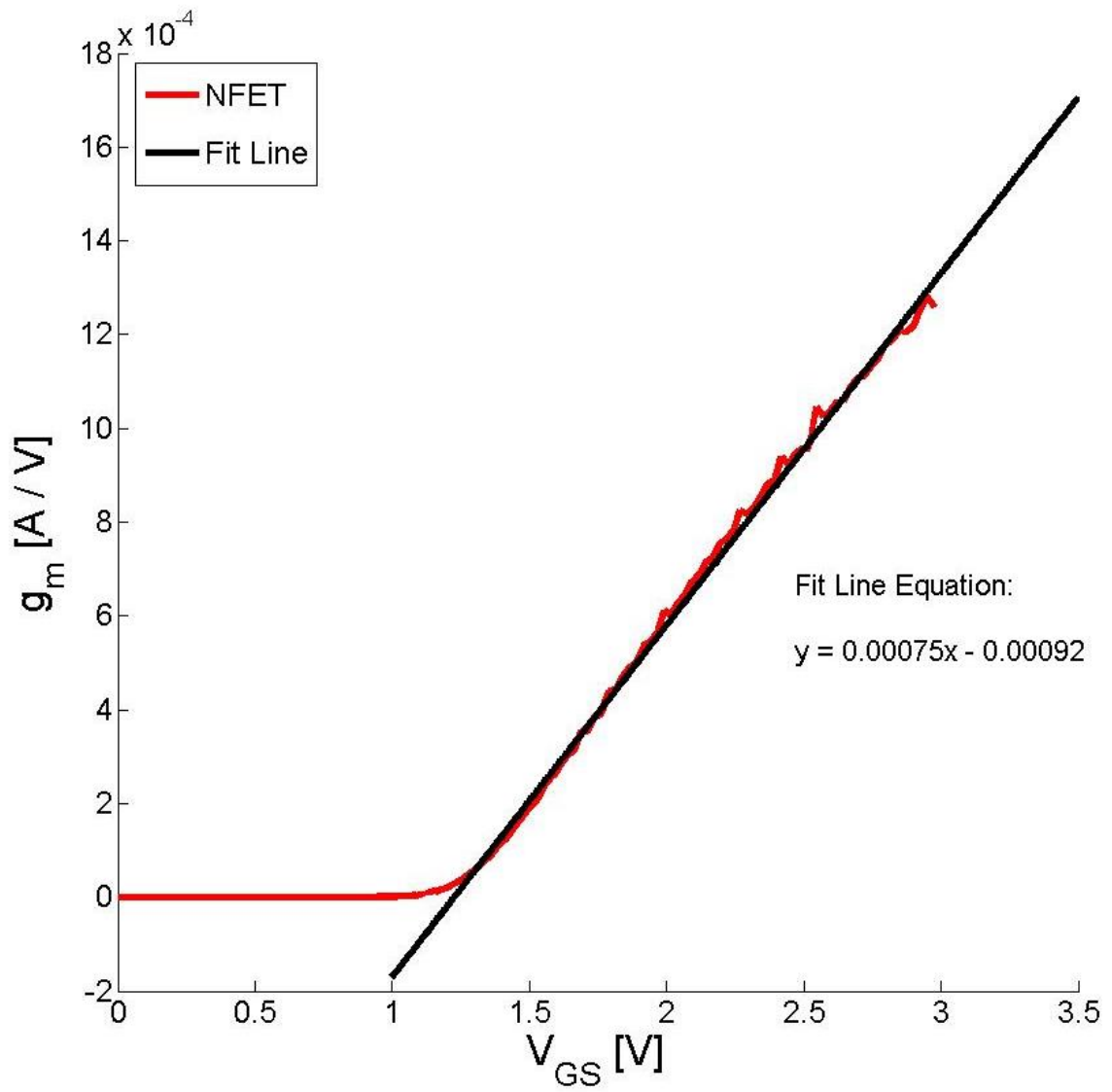


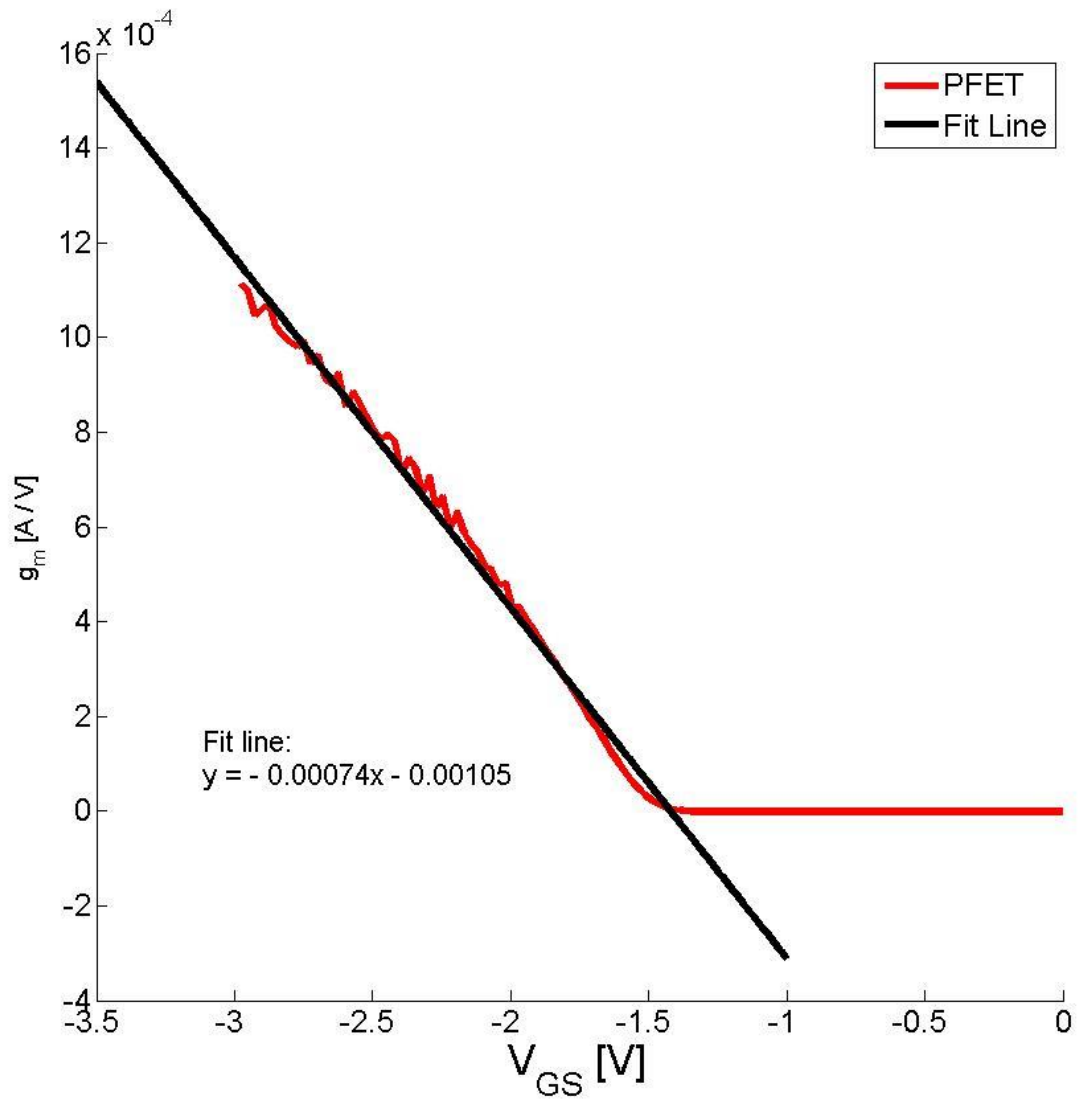
1. NFET is in cutoff, PFET is linear
2. NFET is in saturation, PFET is linear
3. Both are in saturation
4. NFET is linear, PFET is in saturation
5. NFET is linear, PFET is in cutoff

Post-Lab Work

2.3:

a)



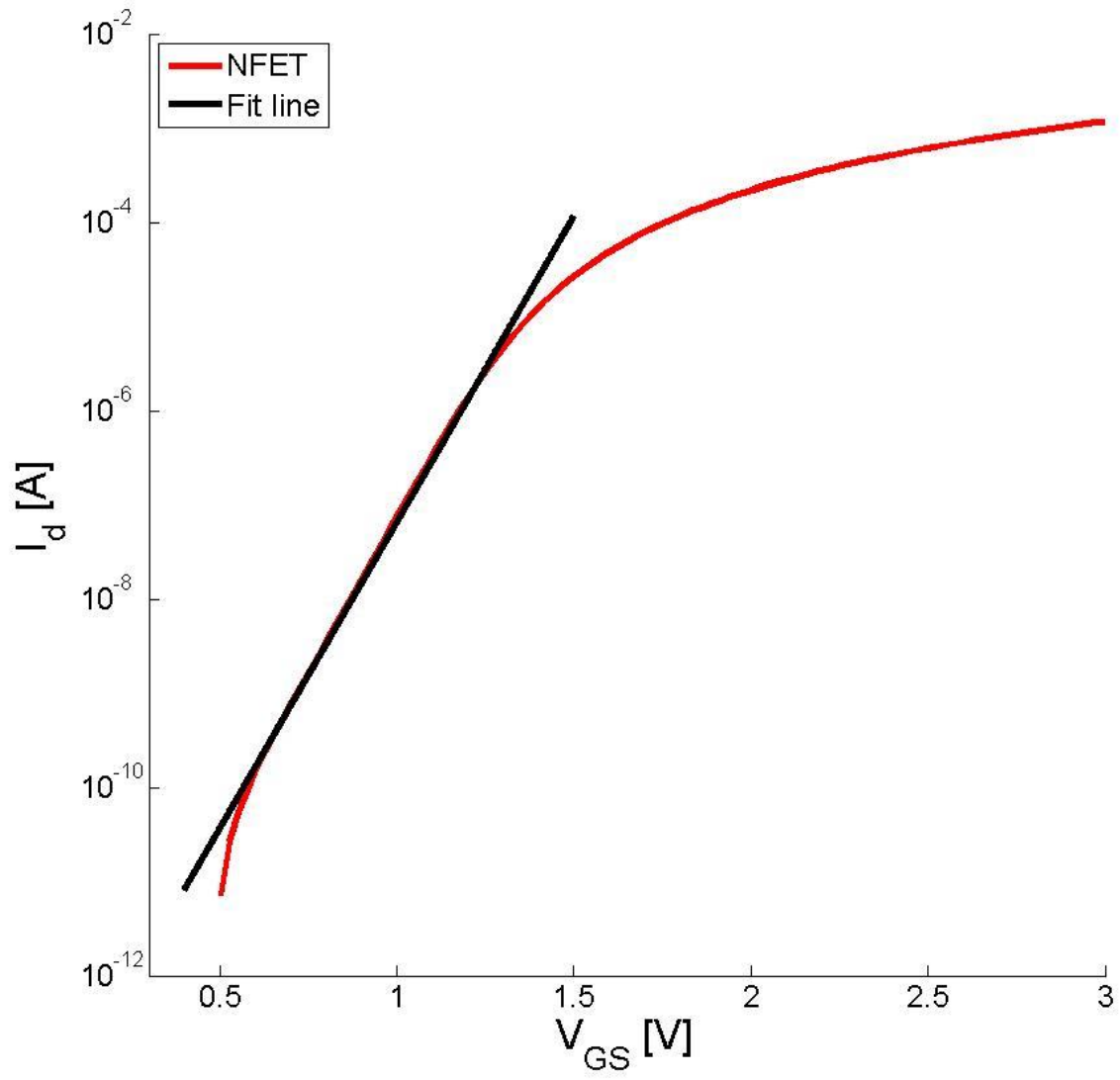


$V_{TN} = 1.23 \text{ V}, \quad k_n = 7.5 \times 10^{-4} \text{ A/V}^2$

$V_{TP} = -1.42 \text{ V}, \quad k_p = -7.4 \times 10^{-4} \text{ A/V}^2$

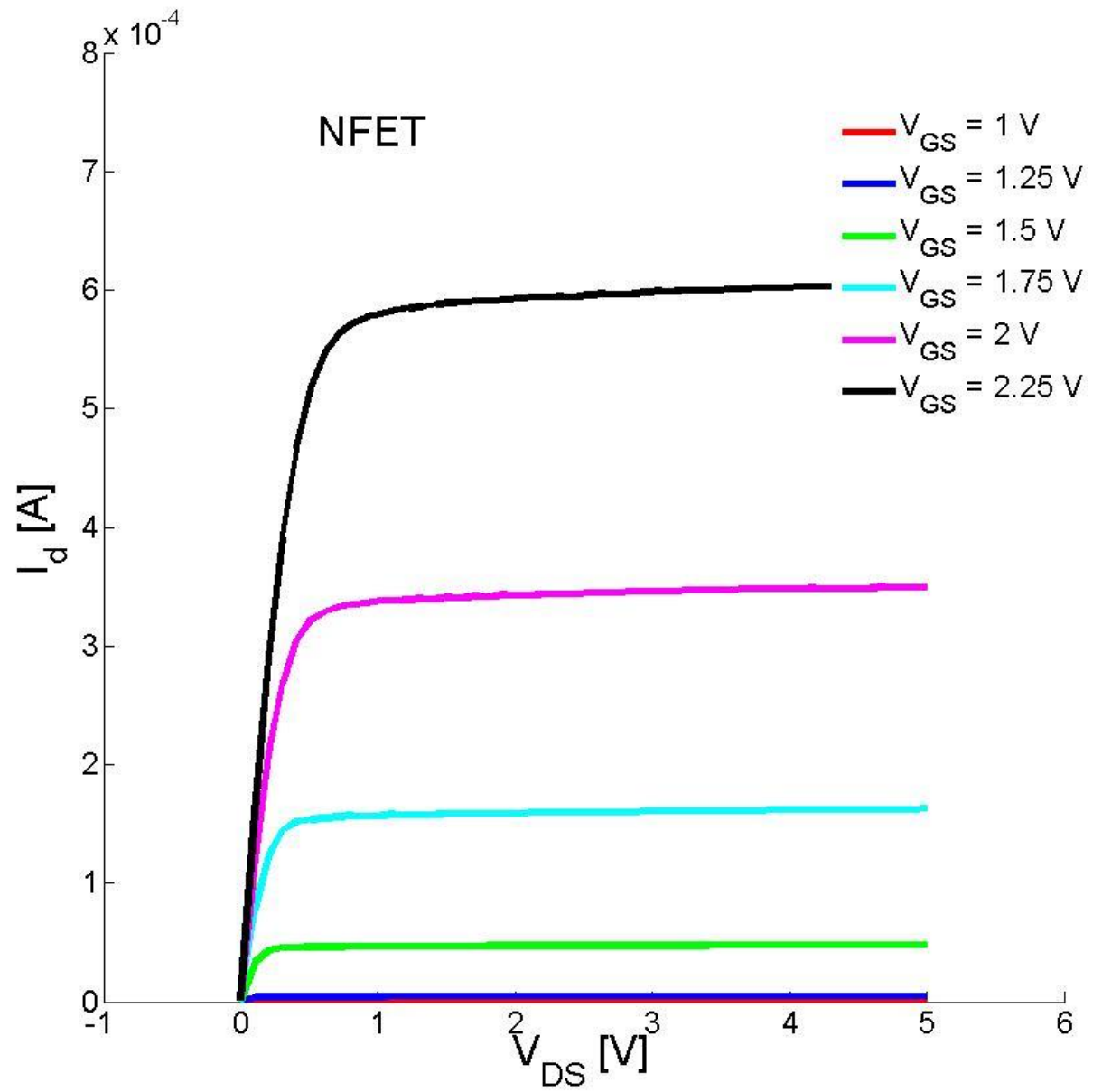
It is clear to see from these measurements that the device parameters for the NFET and PFET are in good agreement.

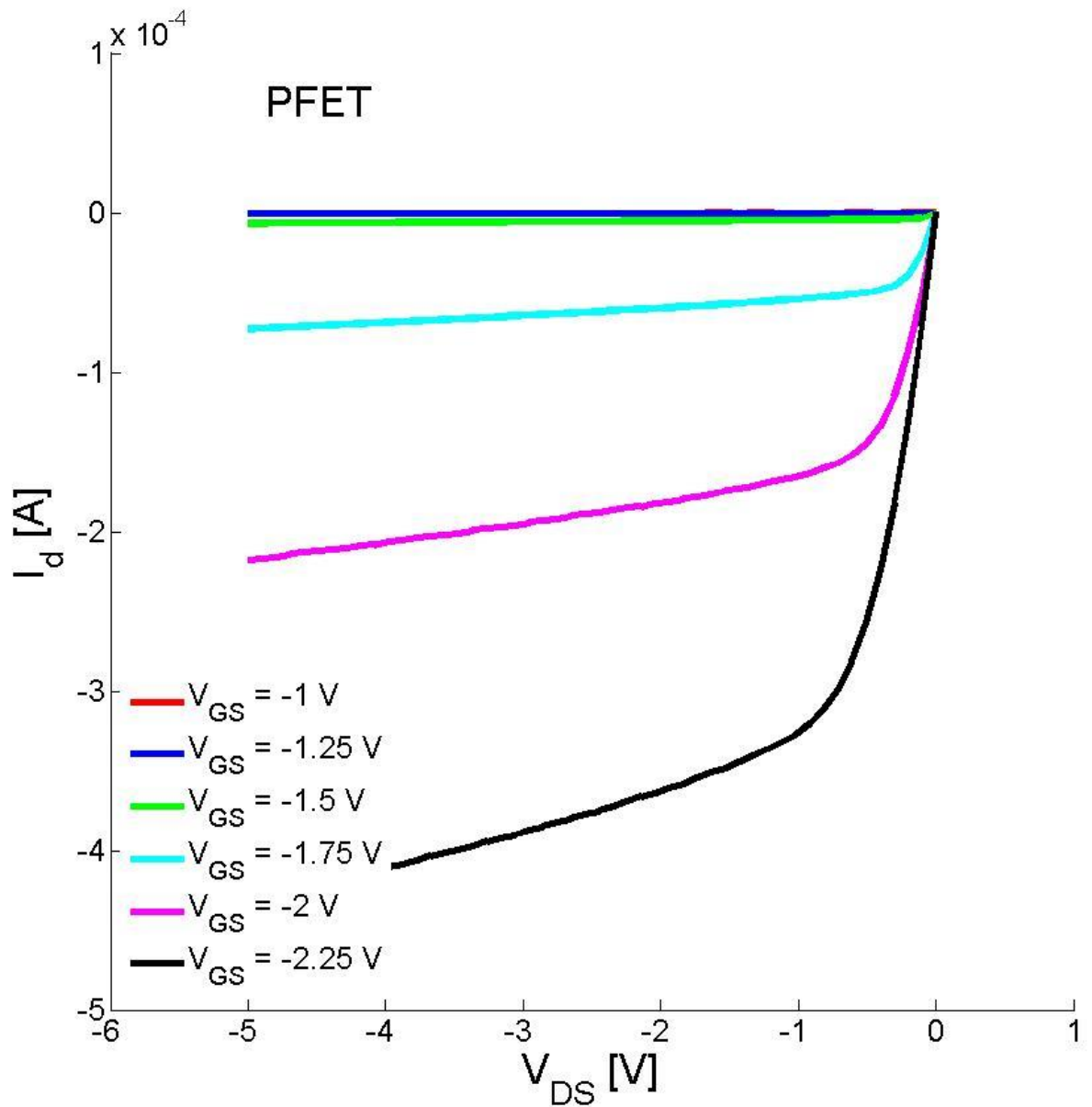
b)



Measured inverse slope value was approximately 147 mV/dec.

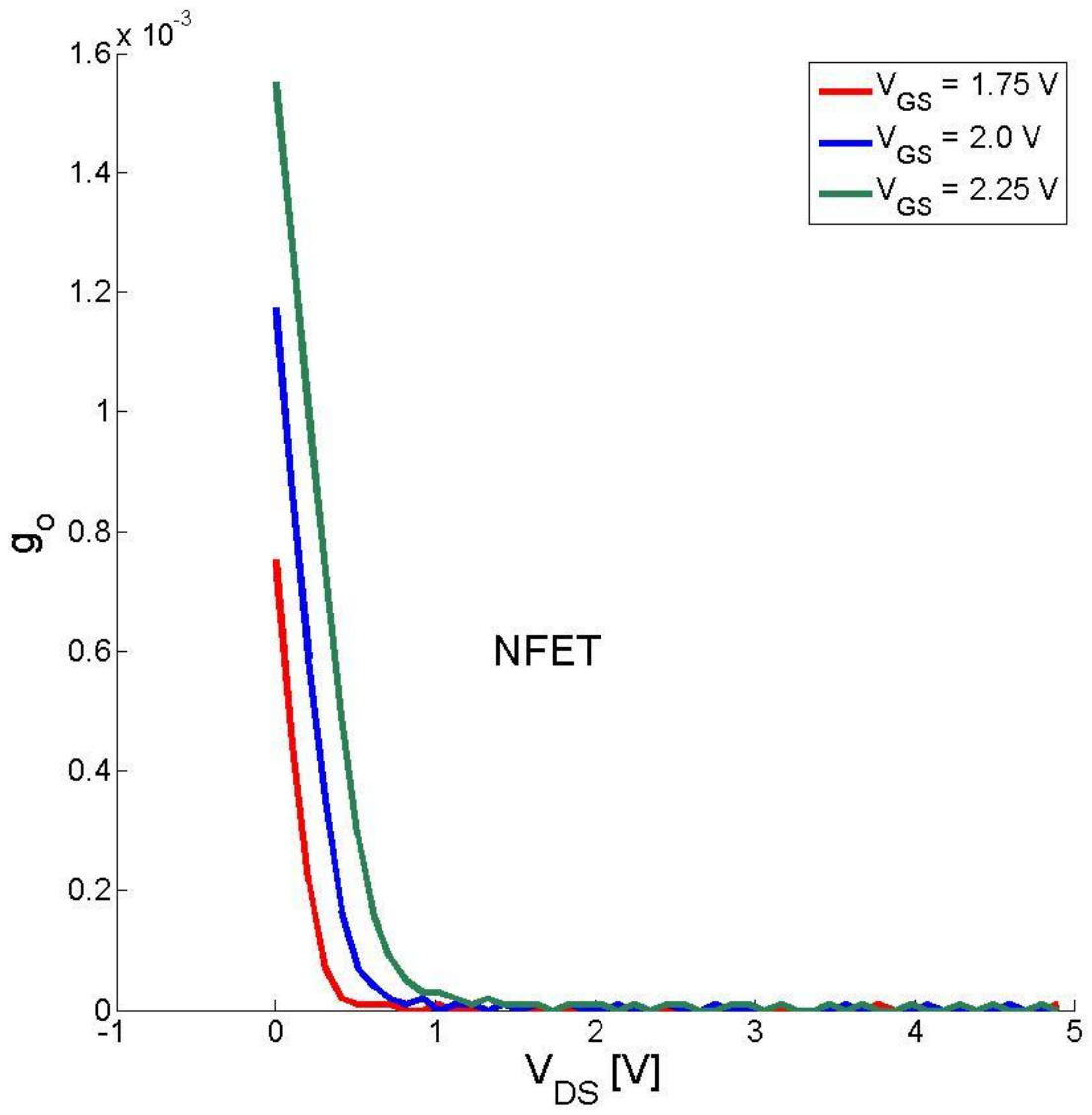
c)

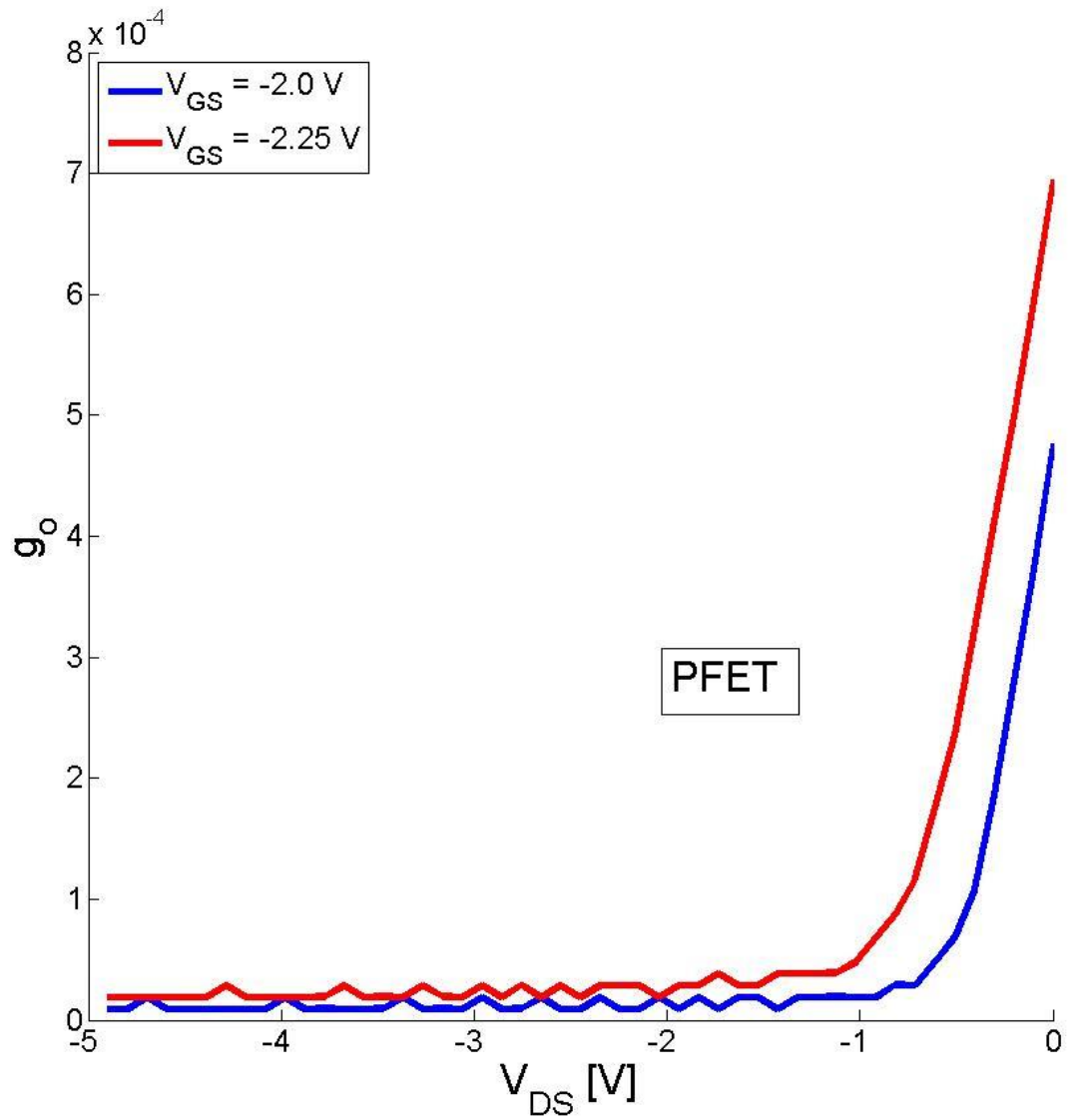




There are several features of these output curves that are different between the NFET and PFET cases: 1) the slope of the output curve above threshold is much higher in the case of the PFET, 2) a high V_{GS} bias is required in the PFET case to produce an appreciable output.

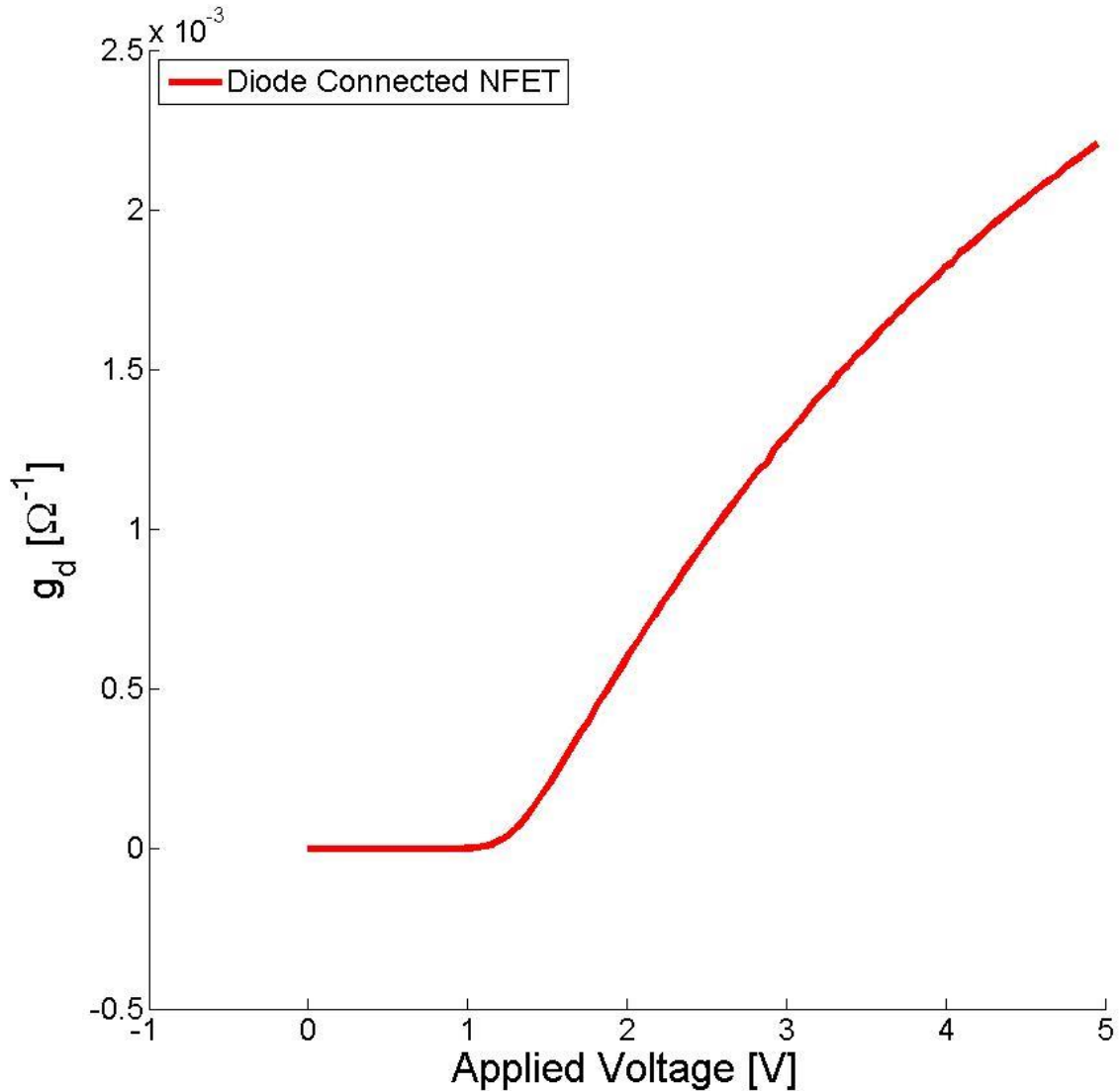
d)





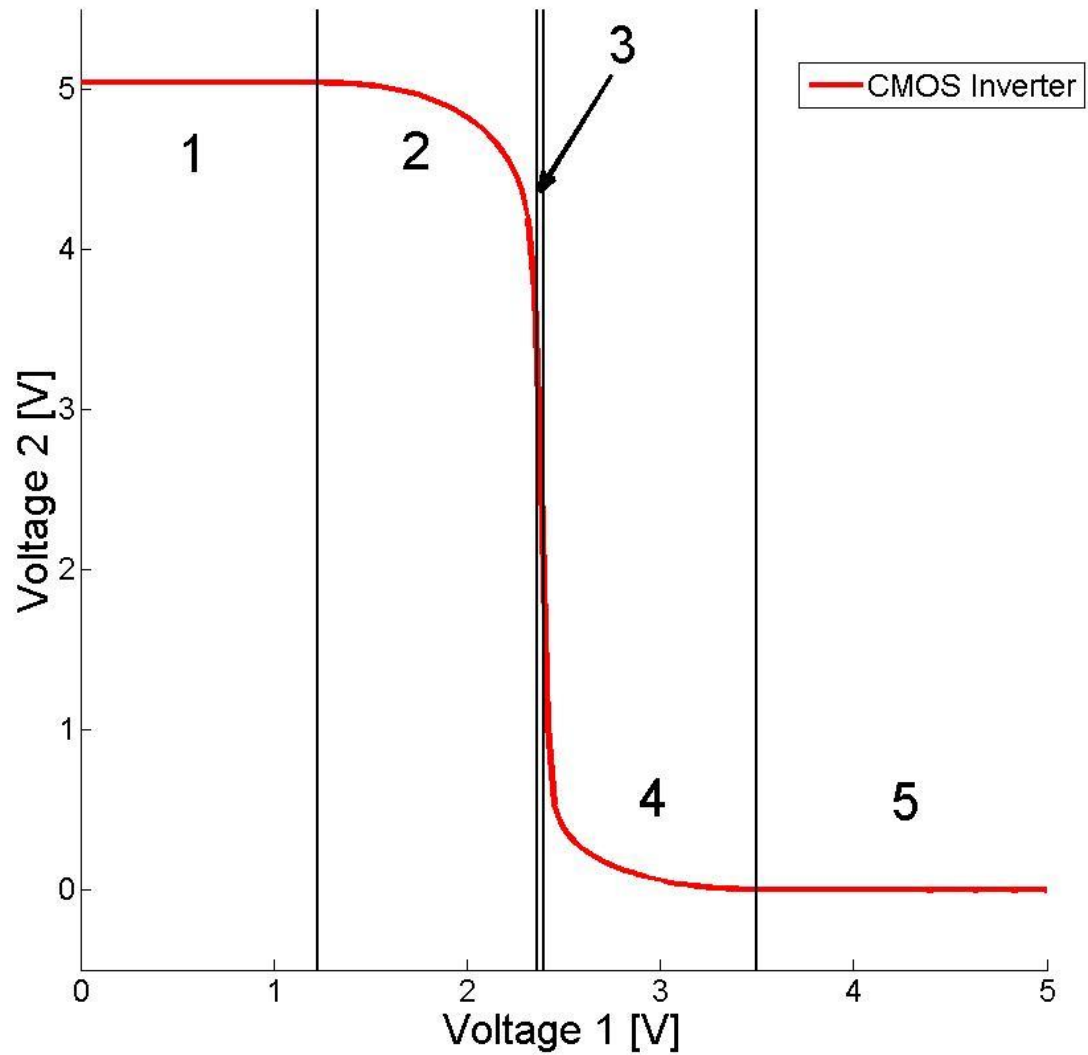
Recall that here $V_{TN} = 1.23$ V and $V_{TP} = -1.42$ V.

e)



The measured differential conductance is visually quite similar to the measured transconductance of part 2.3 a). However, it is clear that the differential conductance data plotted here only approximates the measurements of part 2.3 a), as there is a significant deviation from the linear behavior observed in the measured transconductance.

f)



The corresponding regions of operation are given below:

1. NFET is in cutoff, PFET is linear
2. NFET is in saturation, PFET is linear
3. Both are in saturation
4. NFET is linear, PFET is in saturation
5. NFET is linear, PFET is in cutoff