

Q1.

a)

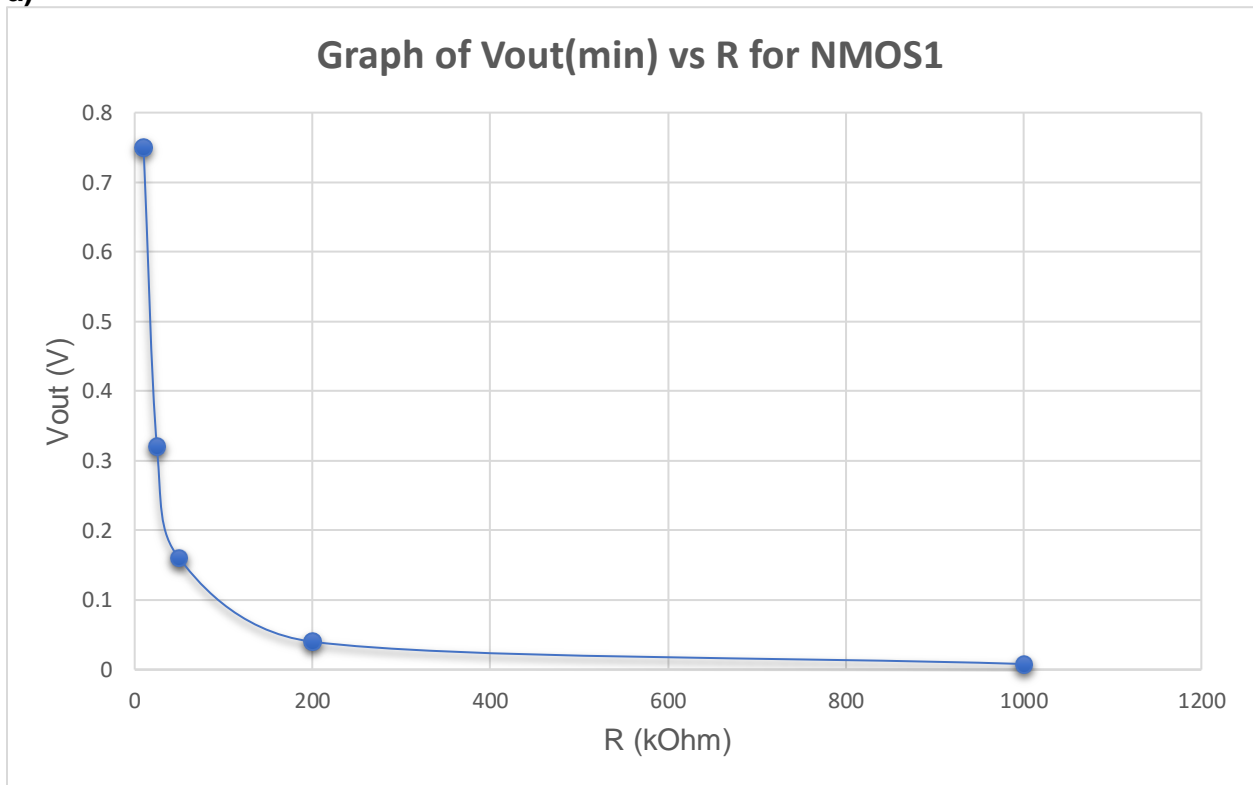


Figure 1: Plot of Vout (min) VS R for NMOS1

b)

Delay = V_{out} – V_{in} [We recorded at 1.25 V, t for V_{out} = 1.670 ns and t for V_{in} = 1.0997 ns)

=> Delay = 1.670 – 1.0977

=> Delay = 0.5703 ns [Ans]

c) The main disadvantage of making R very large is that the change in voltage (V_{out}) is very low and eventually the change in voltage will become negligible with increasing resistance.

Q2.

a)

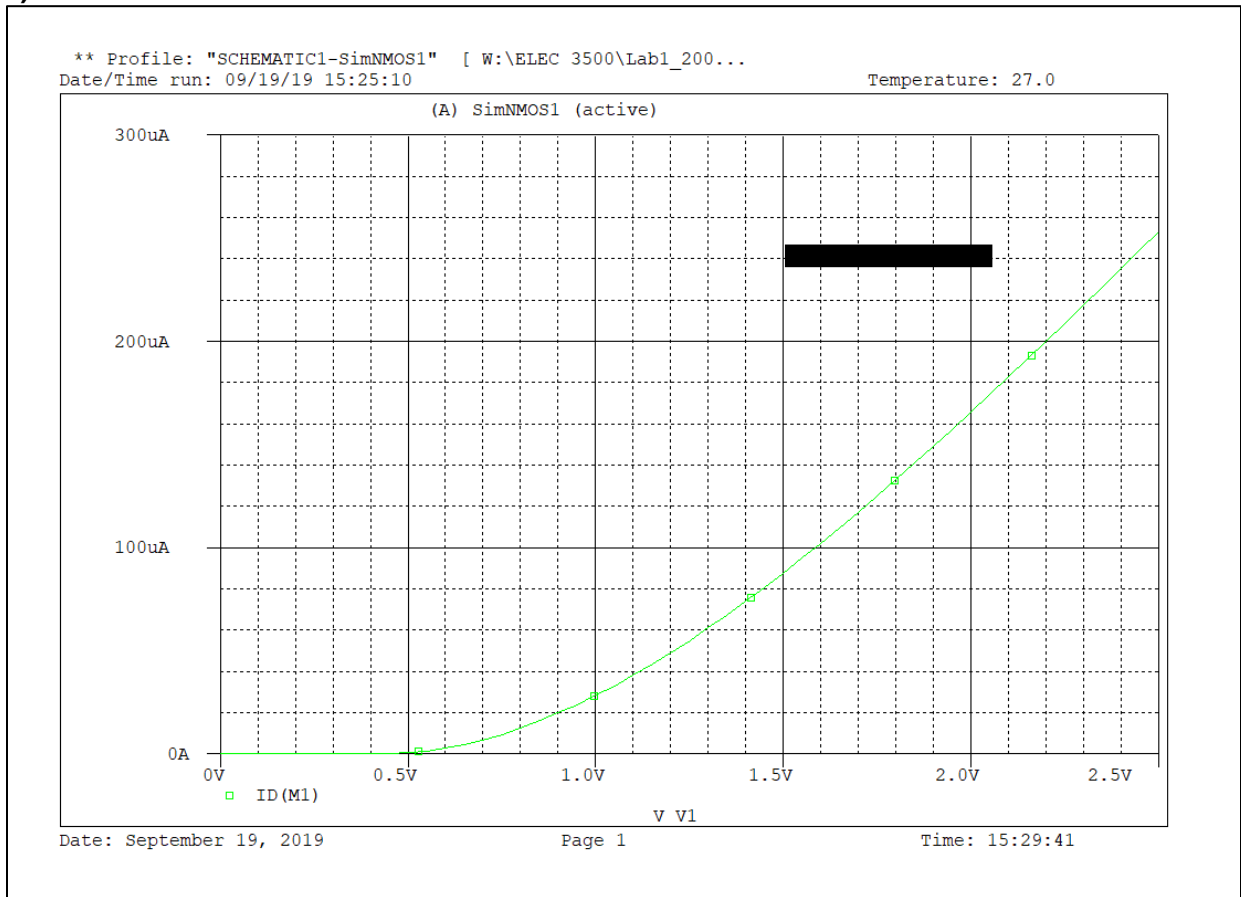


Figure 2: Plot of I_D vs V_{GS} at $R = 1k\Omega$

b) Yes, there is a sharply defined threshold voltage.

c) An estimation from the plot is that the threshold voltage is 0.4V. The current at this voltage is 0.8 uA, and the maximum current is recorded to be 240 uA. The current at which threshold voltage is recorded is very minimal.

Q3.

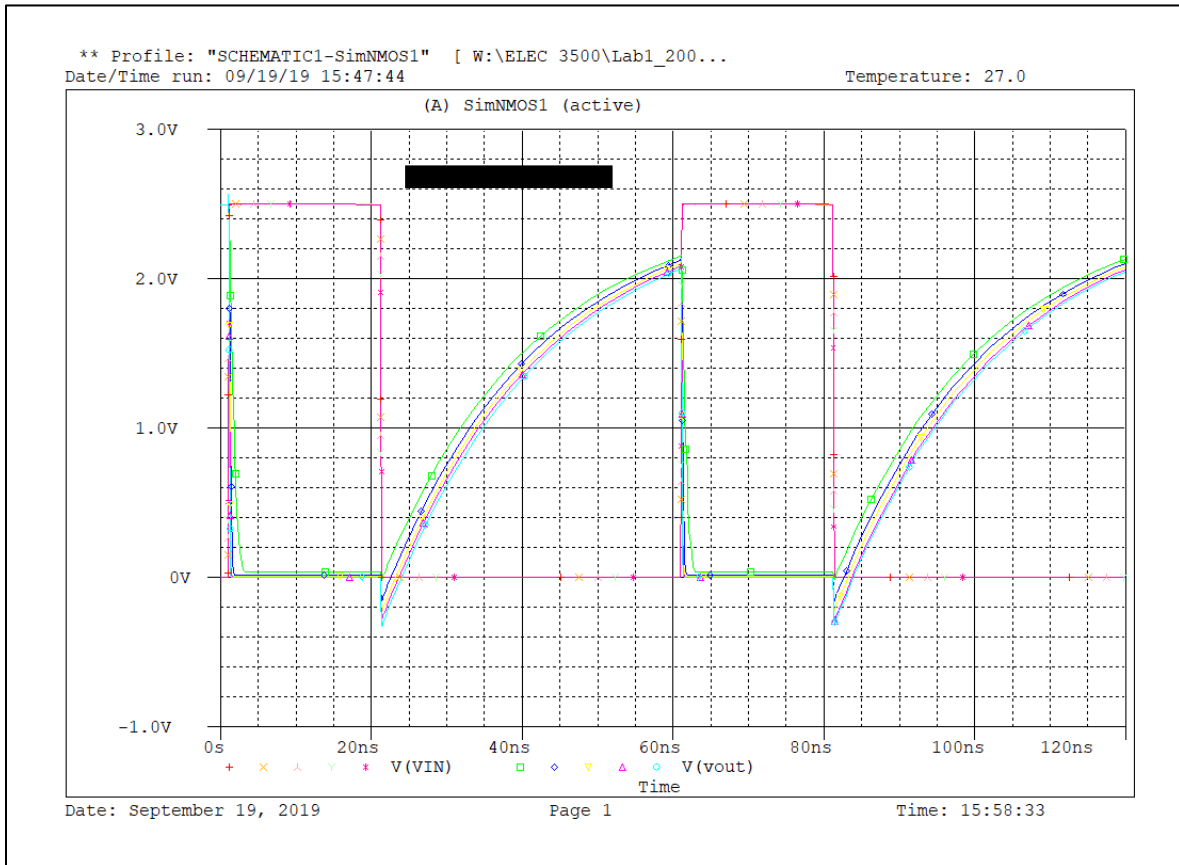


Figure 3: Simulation Sweep of W at R = 200kOhm, L = 1 μ m

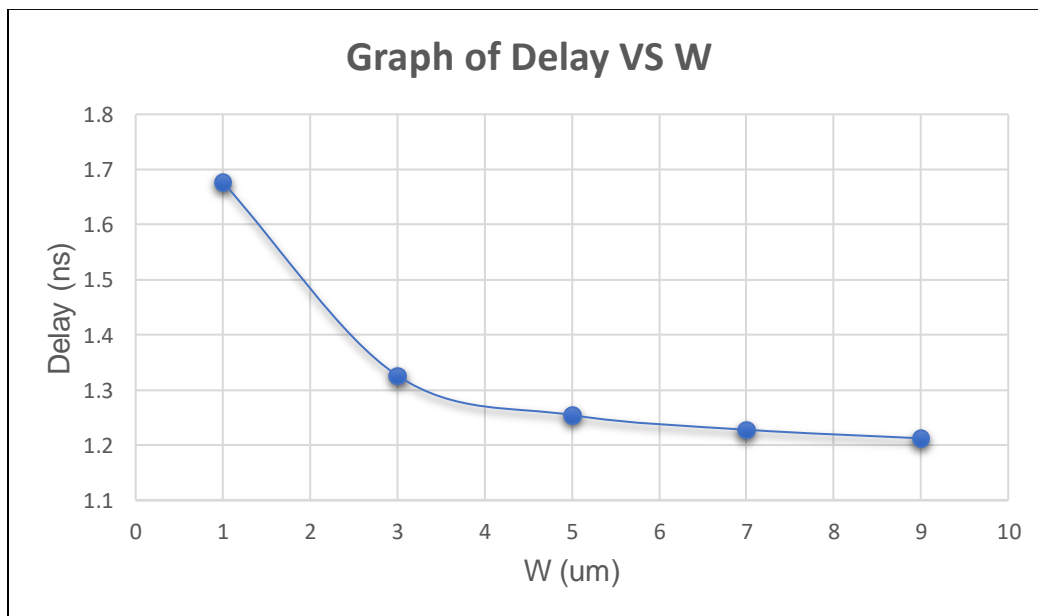


Figure 4: Plot of Delay between Vin and Vout with changing W

Q4.

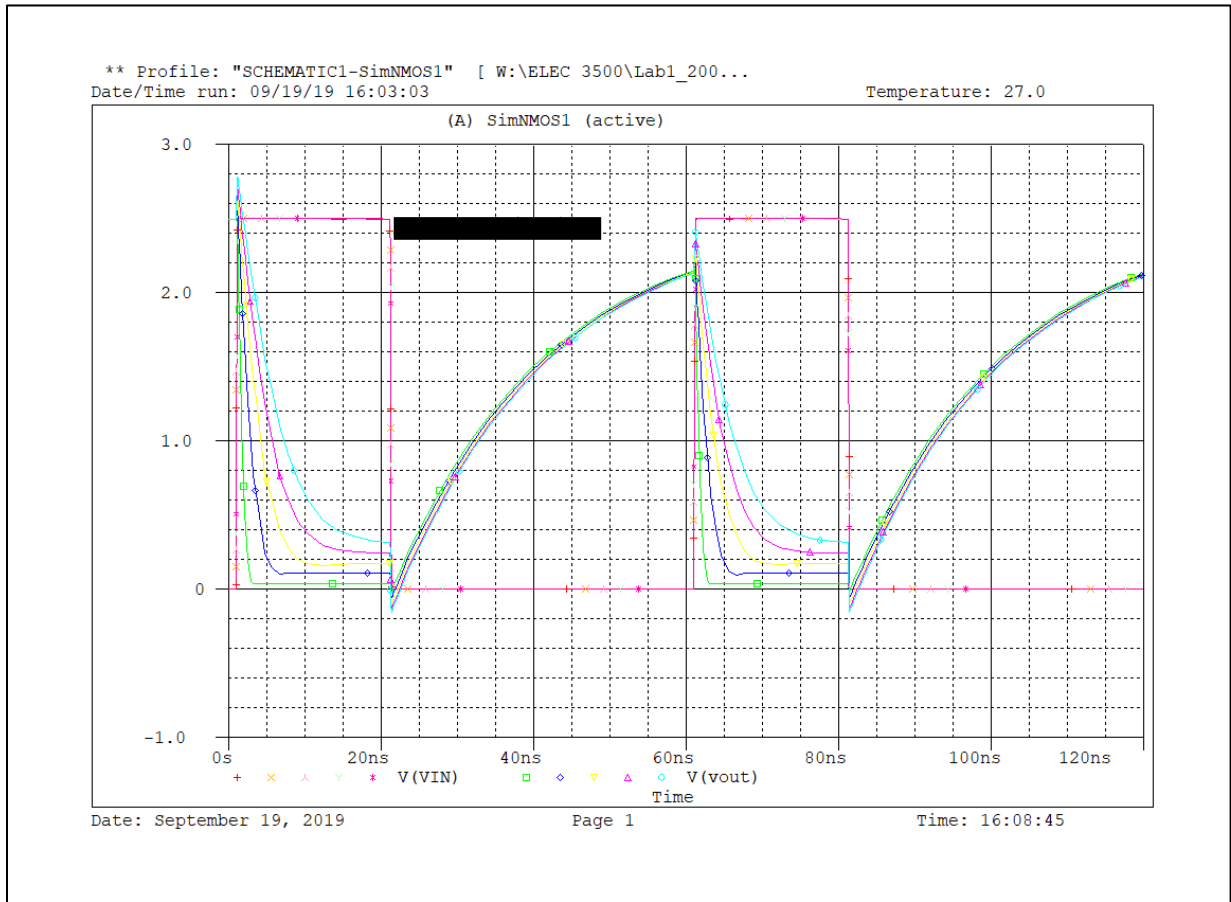


Figure 5: Simulation Sweep of L at R = 200kOhm, W = 1 μm

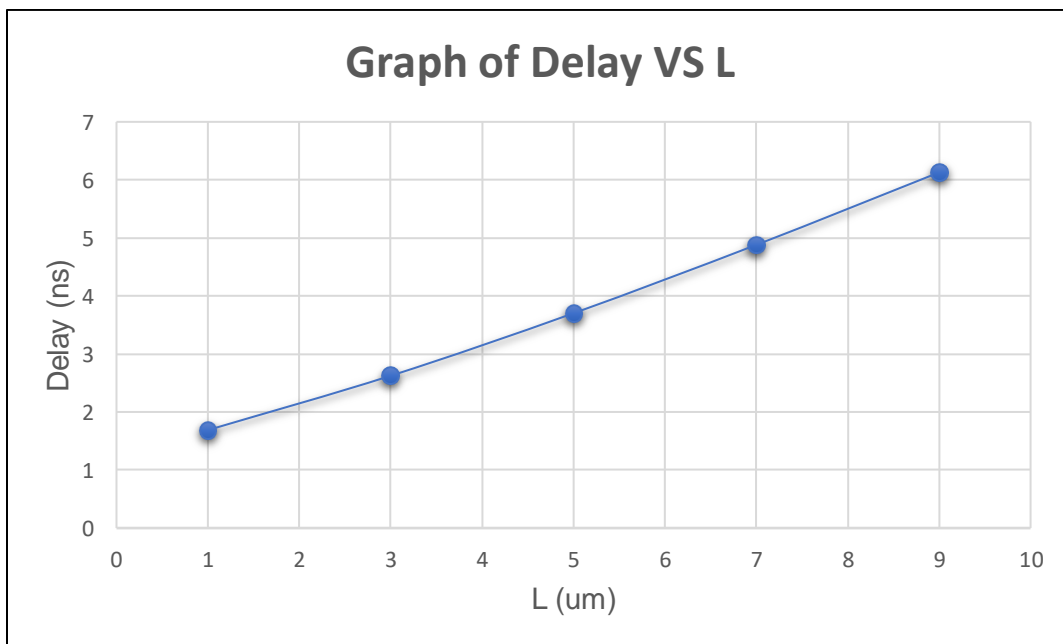


Figure 6: Plot of Delay between Vin and Vout with changing L

Q5.

a)

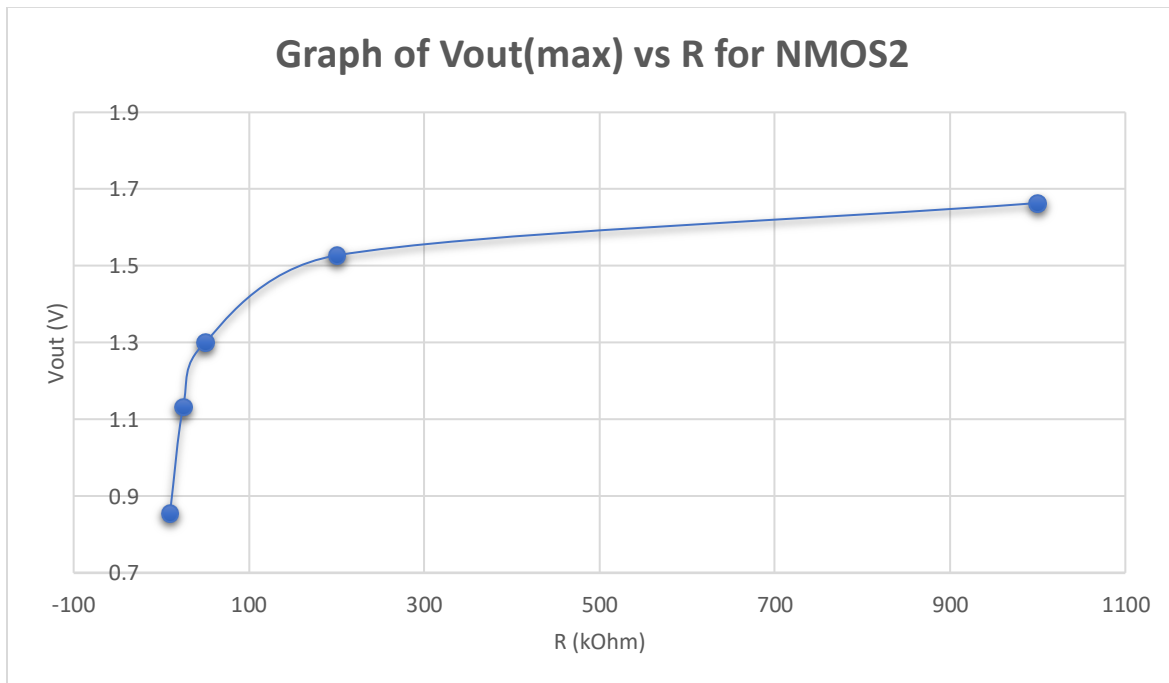


Figure 7: Plot of Vout (max) VS R for NMOS2

b) The threshold voltage is estimated to be 1.7V, which is higher than the value obtained in Q2c (0.4V).

Q6. From observation it can be concluded that digital circuits work better when NMOS transistors are connected to pull the output down.

Q7.

a)

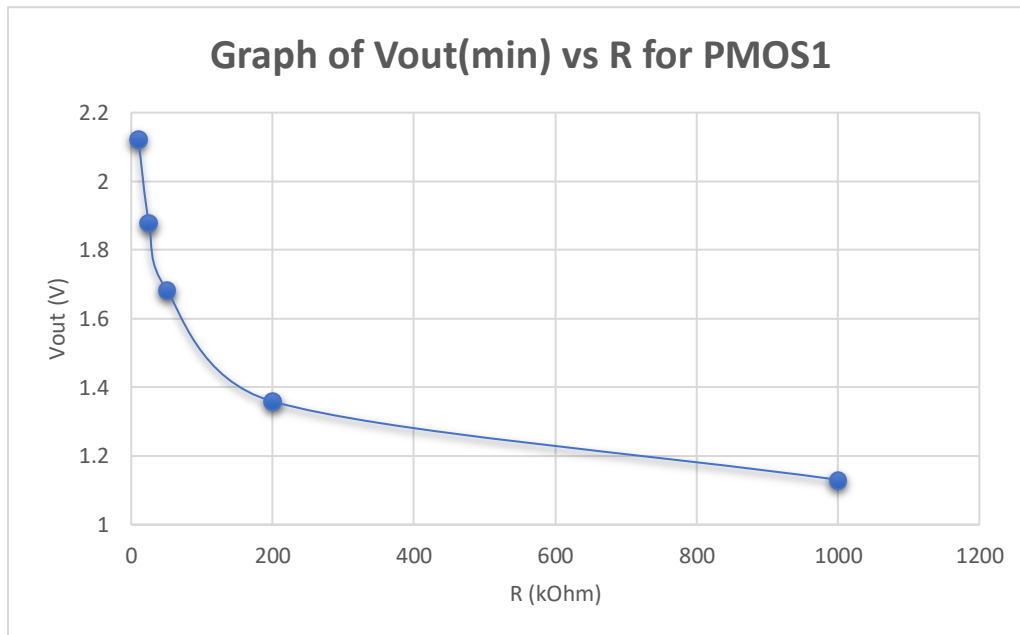


Figure 8: Plot of Vout (min) VS R for PMOS1

b) The closest V_{out} can get to 0V is approximately 0.7V.

c) The threshold voltage is estimated to be 0.7V.

Q8.

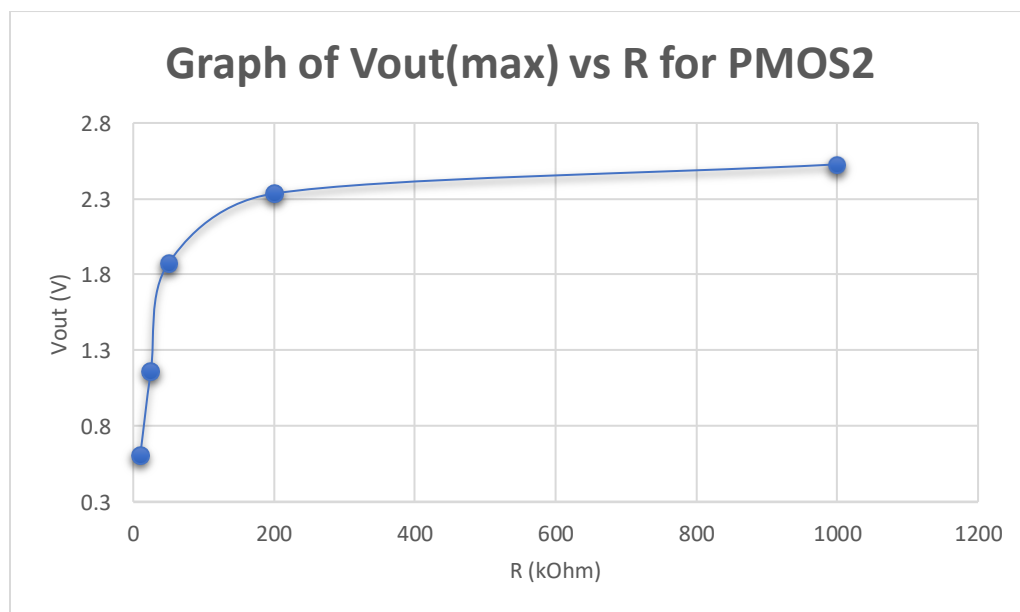


Figure 9: Plot of Vout (max) VS R for PMOS2

Q9. Digital circuits will perform better when PMOS transistors are connected to pull up the output.

Q10.

a) Delay = $V_{out} - V_{in}$ [We recorded at 1.25 V, t for $V_{out} = 22.129$ ns and t for $V_{in} = 21.300$ ns)

=> Delay = $22.129 - 21.300$

=> Delay = 0.829 ns [Ans]

b) The delay is longer in PMOS than in NMOS and this is because there is a decrease in current in the circuit.