

National Taiwan Normal University
CSU0007 - Basic Electronics Homework 6

100 points total. Due on 11:59PM, Friday, 6/12/2020.

Submit your answer via Moodle. Clearly state your analysis to earn full score.

Please tweak your image files to help save some ink! For example, grey-out the background color. Thanks!

請影像處理您的作業照片以節省列印墨水 (例如把背景顏色調淡)~ 謝謝!

By default, we assume that all MOSFETs have $V_T=1$ V, $K=1$ mA/V², and we use the SCS model.

- 1 Consider the MOSFET amplifier in Figure 8.1 in the textbook.
 - 1.1 (20 points) Explain in your own words why in the small-signal model of this amplifier (Figure 8.16 in the textbook page 419), we would treat one end of the R_L as grounded (為何 R_L 的一端視為接地)?
 - 1.2 (20 points) Suppose we want to make the magnitude of the small-signal gain equal to 10, and suppose that we are given $V_S=15$ V and $R_L=15$ k Ω . What should be the value of V_I for this purpose?
 - 1.3 (20 points) Following Question 1.2, verify that with such a configuration, the MOSFET is indeed operating in the saturation region.

- 2 We have discussed the use of a *buffer* circuit to restore a distorted signal (page 63 in the lecture note; Section 6.9 in the textbook). We may implement a buffer circuit using a MOSFET circuit that is also called a *source follower* (the output signal would *follow* the change in the input signal). Before working on the following questions, be sure to study examples 7.8, 7.10, 7.11, and 8.4 in the textbook.
 - 2.1 (20 points) Consider the source-follower circuit in Figure 7.24 on page 349, and instead we suppose that $v_{IN}=3$ V, $K=1$ mA/V², and $V_T=1$ V, and that the resistor has resistance equal to 2 k Ω . Assume that the MOSFET is operating in the saturation region. Determine the value of current i_D .
 - 2.2 (10 points) Now, consider the circuit in Figure 7.45 on page 369. Suppose that we chose the DC voltage offset $V_B=5$ V and that v_A is a sinusoidal large signal. What could be the maximum possible peak-to-peak swing of v_A so that v_A will not be clipped? (Review the phenomenon of clipping on page 351 in the textbook; note that on that page the example does not have any DC voltage offset).
 - 2.3 (10 points) Now, suppose that v_A is a small signal. Further, suppose that a resistor R_L is attached to the output port, and therefore the circuit becomes as that of Figure 8.38 on page 436 in the textbook (Think of $v_I=V_B+v_A$ where v_A is a small signal). Assuming that the MOSFET operates in the saturation region, and $R_S=R_L=1$ k Ω , $V_{GS}=3$ V, $V_T=1$ V, and $K=1$ mA/V². Determine the small-signal gain $|v_o/v_i|$.