SANTA CLARA UNIVERSITY	ELEN 115 – Spring 2023	S. Krishnan
Homework #9-Part 1		

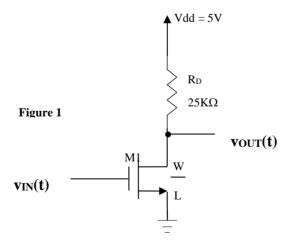
1. The MOS circuit in Figure 1 has a transistor M<sub>1</sub> with parameters

$$V_T = 1.2 \text{ V}, W = 25 \mu \text{m}, L = 5 \mu \text{m}, \lambda = 0, \text{ and } k_n' = 40 \mu \text{A/V}^2$$

The input to the MOS circuit is  $v_{IN}(t)$  and the output is  $v_{OUT}(t)$ .

## Clearly show all the steps of your work.

- (a) Draw a rough voltage transfer curve showing v<sub>OUT</sub> vs. v<sub>IN</sub> for the circuit. [40]
  - (i) Label all points and axes on the graph.
  - (ii) Indicate the regions of operation of  $M_1$  for the various portions of the graph.
  - (iii) Indicate the critical points on the graph and find  $v_{OUT}$  values for when M1 changes region of operation and when  $v_{IN} = 0V$  and  $v_{IN} = Vdd$ .
- (b) The MOS circuit is used as an amplifier and various inputs are given to the amplifier. Will it function properly providing an undistorted output? **Explain why or why not for each case.** 
  - (i)  $v_{IN}(t) = 1 + \cos 2\pi 10^3 t$
  - (ii)  $v_{IN}(t) = 1 + 0.25 \cos 2\pi 10^3 t$
  - $(iii)v_{IN}(t) = 1 + 0.1 \cos 2\pi 10^3 t$
  - $(iv)v_{IN}(t) = 2 + \cos 2\pi 10^3 t$
  - (v)  $v_{IN}(t) = 2 + 0.25\cos 2\pi 10^3 t$
  - $(vi)v_{IN}(t) = 2 + 0.1 \cos 2\pi 10^3 t$
- (c) For any ONE of the inputs that provide an undistorted output in part (b) [50]
  - (i) Mark the operating point on the VTC.
  - (ii) What is  $V_{OV}$  at the operating point.
  - (iii) Find the transconductance of M1 at the operating point.
  - (iv) Find the gain of the amplifier at the operating point.
  - (v) For the input you chose draw  $v_{IN}(t)$  and the corresponding  $v_{OUT}(t)$ .



Elen 115 \_\_\_\_\_\_ HW \_\_\_\_\_