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EE225500 電 子 學 **Quiz 4** **Spring 2021**

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Part1 Single choice (50%)

For the following seven questions, please choose the most appropriate answer:

(B) 1. For a n-channel MOSFET, with V_{TH}=1V, V_D=V_G=2V, V_S=0V, this device is operation in **(A)** Linear region ;**(B)** Saturation region; **(C)** Active; **(D)** Cutoff

(A) 2. MOSFET are often used as an amplifier, which condition is ideal for a voltage amplifier? **(A)** $R_{in} = \infty$, $R_{out} = 0$; **(B)** $R_{in} = 0$, $R_{out} = \infty$; **(C)** $R_{in} = R_{out} = \infty$; **(D)** $R_{in} = R_{out} = 0$

(B) 3. For a n-channel MOSFET, which statement is **right**?

(A) Source and drain are doped with p+ in n-substrate

(B) Source and drain are interchangeable since they are symmetry

(C) When $V_G > V_{TH}$, hole concentration is larger than electron concentration just under the gate, forming inversion layer called "channel"

(D) In saturation region, drain current is independent of gate voltage

(D) 4. For a p-channel MOSFET in saturation region, which change will **NOT** increase drain current I_D?

(A) Increase oxide capacitance Cox

(B) Increase channel width

(C) Decrease channel length

(D) Increase gate voltage

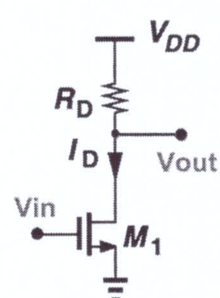
(A) 5. Which correct statement is for a common-source stage?

(A) $R_{in} \sim \infty$; **(B)** It is a non-inverting amplifier; **(C)** Gain will increase when a small loading resistor is added to the output. **(d)** Output resistance is independent of I_D.

Part2 Calculation (50%)

Consider the circuit below, $\mu_n C_{ox}$ = 200μA/V², W/L = 8um/1um, λ=0.1V⁻¹ for M_1, while V_{DD} = 3V, R_D = 5kΩ and V_{TH} = 0.5V.

1. What kind of amplifier it this? (CS, CD, CG)
2. What is I_D so that V_{out} = 2V?
3. Find the small-signal parameters, g_m, r_o of M_1 under this I_D?
4. Find the input, output resistance and small-signal gain of this stage.



1. CS

2. $I_D = \frac{V_{DD} - V_{out}}{R_D} = 200\,\mu A$

3. $g_m = \sqrt{2 \cdot \mu_n C_{ox} \cdot \frac{W}{L} \cdot I_D} = 8 \cdot 10^{-4}$

$r_o = \frac{1}{\lambda I_D} = 50000\ \Omega$

4. $R_{in} = \infty$

$R_{out} = r_o \parallel R_D \doteqdot 4545\ \Omega$

$A_V = -g_m R_D = -4$