

## 科目：電子學二 ( 電路 )

適用：電機系

考生注意：

1. 依次序作答，只要標明題號，不必抄題。
2. 答案必須寫在答案卷上，否則不予計分。
3. 限用藍、黑色筆作答；試題須隨卷繳回。

本 試 題

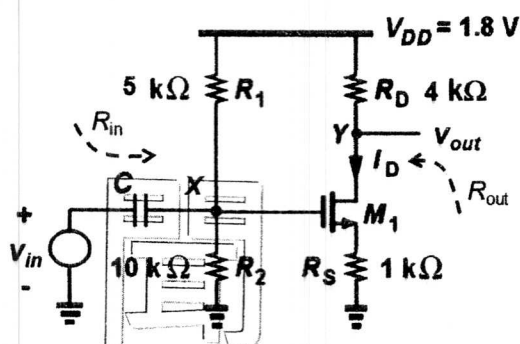
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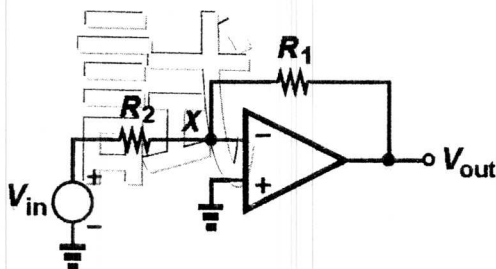
1. For the circuit shown below, MOSFET  $M_1$  has  $V_{TH} = 0.5 \text{ V}$ ,  $k' = 100 \mu\text{A/V}^2$ ,  $(W/L) = (2/0.25)$ ,  $\lambda = 0.05 \text{ V}^{-1}$ . Also,  $I_D = k'(W/L)(V_{GS} - V_{TH})^2$ ,  $g_m = 2I_D(V_{GS} - V_{TH})$ ,  $r_o = 1/(\lambda I_D)$ . Assume the capacitor  $C$  is large enough.

- (a) Find the DC voltage value at  $X$  and  $Y$ , and the operating point ( $V_{GS}$ ,  $I_D$ ) of  $M_1$ . [10%]
- (b) Find the input impedance  $R_{in}$  and output impedance  $R_{out}$ . [10%]
- (c) Find the AC voltage gain  $A_v = (V_{out}/V_{in})$ . [10%]



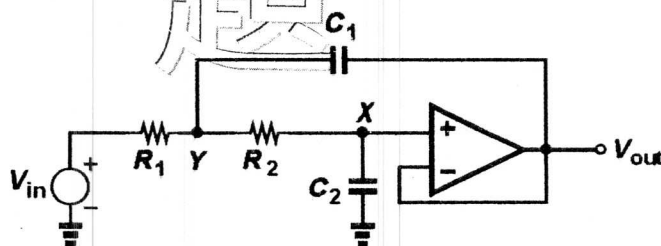
2. For the circuit shown below,  $R_1 = 8 \text{ k}\Omega$ ,  $R_2 = 2 \text{ k}\Omega$ .

- (a) Assume the op-amp has infinite gain, what is its voltage gain,  $A_v = \frac{V_{out}}{V_{in}}$ ? [5%]
- (b) If the gain of op-amp is not ideal,  $A_0 = 500$ , what is the gain error of  $A_v$  in (a)? [10%]



3. Assume the gain of the op-amp in the circuit below is infinite.

- (a) Derive the transfer function,  $H(s) = V_{out}(s)/V_{in}(s)$ . [10%]
- (b) Assume the second pole is much smaller than the first. What are these poles? [10%]



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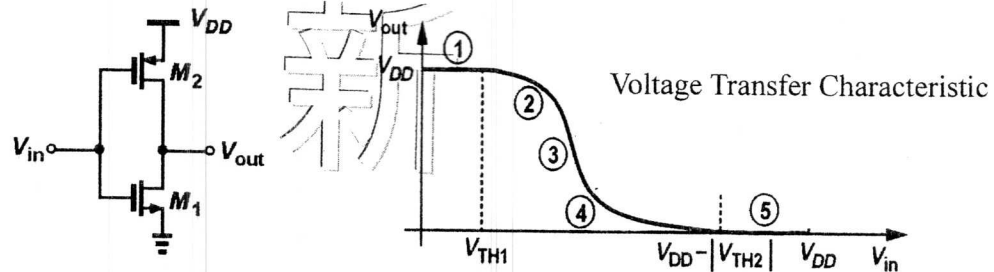
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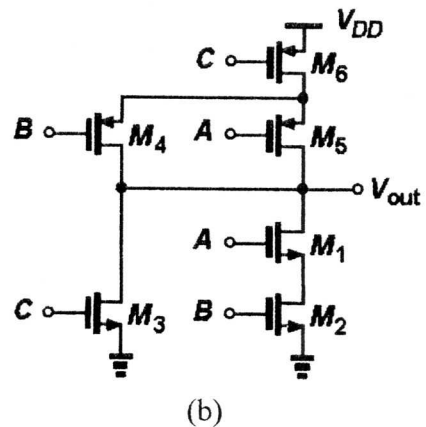
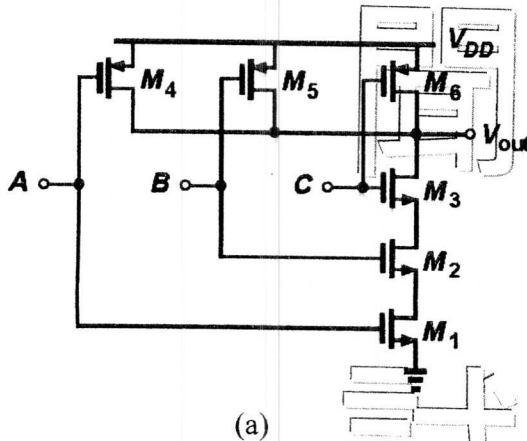
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4. The CMOS inverter with its voltage transfer characteristic plot is shown below. There are five working regions as labeled in the plot. What are the operation modes of the MOSFET  $M_1$  and  $M_2$  for the five regions? (Answer with OFF, Triode, Saturation). [10%]



5. Determine the logical function of the following two circuits. [10%]



6. The op-amplifier in the circuit below is ideal.

- (a) What is an ideal op-amplifier? [5%]
- (b) Find the resistances  $R_1$ ,  $R_2$  and  $R_3$  looking into nodes 1, 2 and 3, respectively. [5%]
- (c) Find the current  $I_1$ ,  $I_2$ , and  $I_3$  in terms of the input current  $I$ . [5%]

