## 國立中正大學 111 學年度碩士班招生考試

# 試 題

### [第2節]

科目名稱	電子學
系所組別	電磁晶片組電機工程學系-計算機工程組晶片系統組

#### -作答注意事項-

- ※作答前請先核對「試題」、「試卷」與「准考證」之<u>系所組別、科目名稱</u>是否相符。
- 1. 預備鈴響時即可入場,但至考試開始鈴響前,不得翻閱試題,並不得書寫、書記、作答。
- 2. 考試開始鈴響時,即可開始作答;考試結束鈴響畢,應即停止作答。
- 3.入場後於考試開始 40 分鐘內不得離場。
- 4.全部答題均須在試卷(答案卷)作答區內完成。
- 5.試卷作答限用藍色或黑色筆(含鉛筆)書寫。
- 6. 試題須隨試卷繳還。

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科目名稱:電子學

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系所組別:電機工程學系-電磁晶片組、計算機工程組、晶片系統組

- 1. Fig. P1 shows a two-stage OP AMP with all transistors using the following parameters:  $\mu_n C_{ox} = 2\mu_p C_{ox} = 200 \,\mu\text{A/V}^2$ ,  $V_{tn} = -V_{tp} = 0.6 \,\text{V}$ ,  $|V_A| = 20 \,\text{V}$ ,  $(W/L)_{M1,\,M2,\,M5,\,M6,\,M7} = 6.25$ , and  $(W/L)_{M3,\,M4,\,M8} = 12.5$ . (Note: Transistors  $M_1$ ,  $M_2$ , and  $M_7$  are matched;  $M_3$  and  $M_4$  are matched; and  $M_5$  and  $M_6$  are matched.  $V_{GSi|i=1-8}$ ,  $r_{oi|i=1-8}$  and  $g_{mi|i=1-8}$  stand for dc voltages of gate-source voltage, output resistance, and transconductance of  $M_{i|i=1-8}$ , respectively.)
  - (a) Assume that two inputs are grounded and channel length modulation effects are ignored, please calculate V<sub>GS1</sub>, V<sub>GS3</sub>, V<sub>GS5</sub>, and V<sub>GS8</sub>. Then, please identify the input common mode range. (5%)
  - (b) Please calculate the overall voltage gain  $(v_o/v_{id})$ , where  $v_{id} = v_I^+ v_I^-$ . (8%)
  - (c) Please show that the common mode gain ( $A_{cm}$ ) of the current-mirror loaded differential amplifier is approximately equal to  $-1/(2r_{o2} \times g_{m5})$ . (12%)
  - (d) Please calculate the CMRR of the current-mirror loaded differential amplifier. (5%)

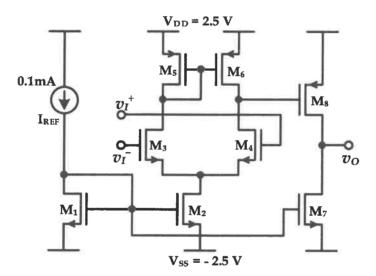


Fig. P1

2. Fig. P2 shows an amplifier circuit, in which the transistor  $M_1$  has  $g_m = 2$  mA/V,  $r_0 = 20$  K $\Omega$ ,  $C_{gs} = 40$  fF,  $C_{gd} = 10$  fF, and  $C_{db} = 10$  fF. Please use open-circuit time constants method to find the upper-3-dB frequency ( $f_H$ ), also determine the unity-gain frequency. (12%)

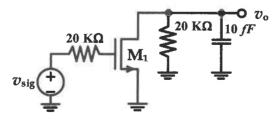


Fig. P2

3. Please implement the CMOS realization of the logic function:  $Y = (A \cdot B + C \cdot D) \cdot E$ . (8%)

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- 4. For a silicon-based pn diode with cross-sectional area  $10^{-4}$  cm<sup>2</sup>, the doping of p-side and n-side are  $5\times10^{17}$ /cm<sup>3</sup> and  $5\times10^{16}$ /cm<sup>3</sup>, respectively. The intrinsic carrier concentration  $(n_i)$ , the thermal voltage  $(V_T)$  and the dielectric constant at 300K are  $1.5\times10^{10}$  cm<sup>-3</sup>, 25.9 mV and  $1.05\times10^{-10}$  F/m, respectively
  - (a) To determine the carrier concentrations (pp, np, nn, pn) on the both sides of pn diode.? (5%)
  - (b) What's the built-in potential  $(V_0)$  over the junction. (5%)
- 5. Fig. P5 is a feedback transconductance amplifier. All the MOS transistors are operated at  $|V_{ov}|=0.2V$  and with  $|V_t|=0.5V$  and  $|V_A|=20V$ . The values of resistors  $R_S$  and  $R_F$  are 10 k $\Omega$ .
  - (a) If the M<sub>1</sub> gate is at zero dc voltage. Under negative feedback, what will be the gate voltage at M<sub>2</sub>? (5%)
  - (b) Please approximate the  $\beta$  value of feedback network. (5%)
  - (c) Please determine the open-loop gain A. (5%)
  - (d) Find the value of Rout. (5%)

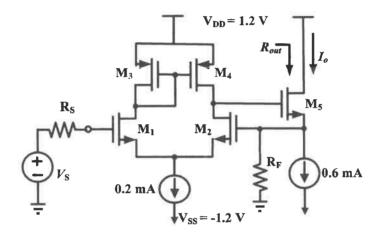


Fig. P5

- 6. Fig. P6 is a common-gate amplifier with current-mirror biased, all of the transistors are with  $k_n = k_p = 5$  mA/V<sup>2</sup>,  $|V_A| = 30$  V, and  $|V_B| = 0.8$  V. R<sub>S</sub> is 50  $\Omega$  and  $v_{sig}$  just only plays as ac signal without dc component.
  - (a) Estimating  $r_0$  for all transistors.? (5%)
  - (b) What's the transconductance of M<sub>1</sub> with a prediction of over-drive voltage Vov<sub>1</sub>? (5%)
  - (c) Finding the values of R<sub>in</sub>? (5%)
  - (d) Finding the values of R<sub>out</sub>? (5%)

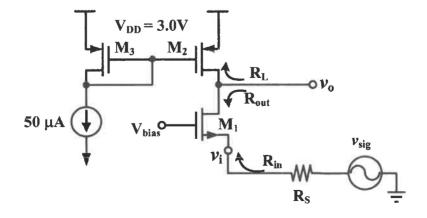


Fig. P6