國立中正大學
109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	電機工程學系－ 電磁晶片組 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」之系所組別、科目名稱是否相符。

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、畫記、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。

國立中正大學 109 學年度碩士班招生考試試題

科目名稱：電子學　　本科目共 3 頁　第 1 頁

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.Find the voltage gain of the differential amplifier circuit in Fig. P1 under the condition that I = 50μA, $|V_{tp}| = V_{tn} = 1V$, $W_1 = W_2 = 120\mu m$, $L_1 = L_2 = 6\mu m$, $\mu_n C_{ox} = 90\ \mu A/V^2$, $\mu_p C_{ox} = 30\mu A/V^2$, $V_A = 30V$, and $V_{DD} = V_{SS} = 2.5V$. (15%)

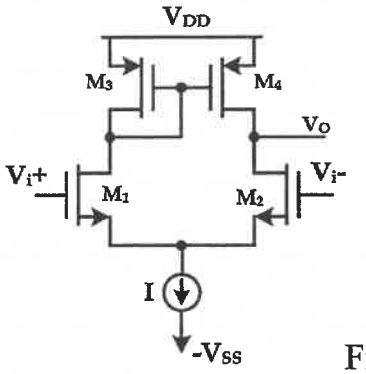


Fig. P1

2.(a) Calculate the output current I_o in Fig. P2. $R_s = 3.6k\Omega$. Assume that $|V_{tp}| = V_{tn} = 1V$, $W_1 = W_3 = W_4 = 12\mu m$, $W_2 = 48\ \mu m$, $L_1 = L_2 = L_4 = L_4 = 0.6\mu m$, $\mu_n C_{ox} = 100\ \mu A/V^2$, $\mu_p C_{ox} = 40\mu A/V^2$, $\lambda_P = \lambda_N = 0$, and $V_{DD} = 3V$. (10%)

(b) If $\lambda_P = \lambda_N = 0.1\ V^{-1}$, estimate the change in I_o for a small change ΔV_{DD} in the supply voltage. (10%)

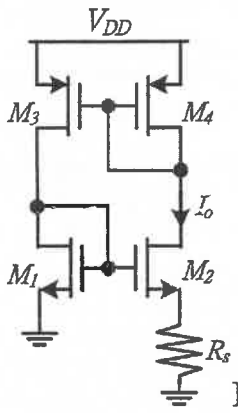


Fig. P2

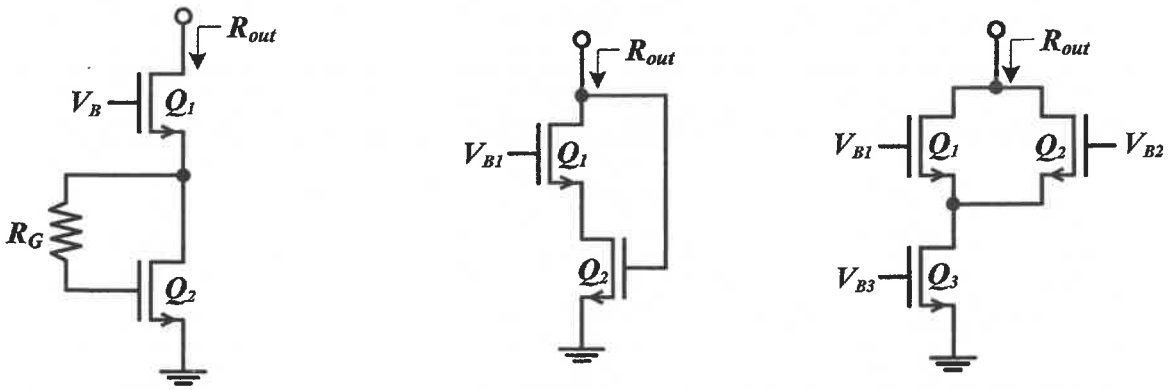
3. A sinusoidal signal $V_{in}(t) = A_m \cos(2\pi f_{in} t)$ is to be converted to a 12-bit digital signal, where $A_m = 2$ V and $f_{in} = 1$kHz.

(a) The signal is sampled at t = 0.5 mS. What is the digital representation of the sampled signal? (5%)

(b) The signal is sampled at t = 0.75 mS. What is the digital representation of the sampled signal?(5%)

(c) What is the error introduced by the quantization in (b)? Express the error in the percentage of the full scale voltage.(5%)

4. Please calculate the output resistance (R_{out}) of the circuits shown in Fig. P4. Assume that all of transistors have the same transconductance g_m and output resistance r_o while $g_m r_o >> 1$. (15%)



(a)　(b)　(c)

Fig. P4

5. A MOS cascade amplifier shown in Fig. P5 was designed to have an input pole of 4 GHz and an output pole of 12 GHz. Assume that Q_1 and Q_2 are perfectly matched and operate in saturation region with an overdrive voltage of 0.2 V, and the process parameters are: L= 0.18 μm, λ= 0, $\mu_n C_{ox}$ = 100 μA/V^2, C_{ox} = 12 fF/μm^2, $C_{GS} = (2/3)WLC_{ox}$, $C_{GD} = WC_o$, C_o = 0.2 fF/μm. Please determine the values of R_G and R_D. (Hint: use Miller's approximation for calculating input capacitance of Q_1.) (15%)

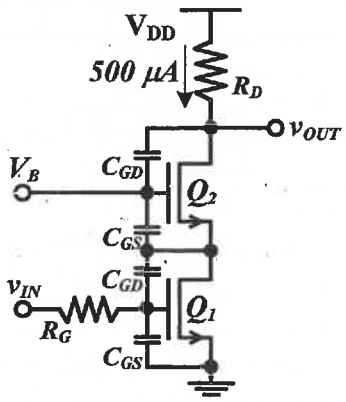


Fig. P5 A cascode amplifier

6. In the circuit of Fig. P6, assume that the reverse saturation current is 5×10^{-17} A for each diode and the thermal voltage is 25 mV, please calculate V_R. (10%)

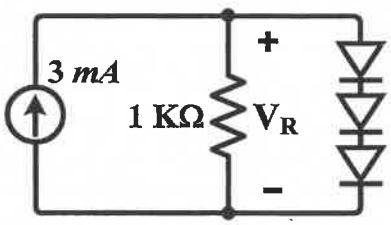


Fig. P6 Diode Circuit

7. In the CMOS Inverter shown in Fig. P7, please determine the voltage of trip point. Assume that $\mu_n C_{ox}$ = 150 $\mu A/V^2$, $\mu_p C_{ox}$ = 75 $\mu A/V^2$, $V_{THN} = |V_{THP}|$ = 0.5 V, and $\lambda_N = \lambda_P = 0$. (Hint: both transistors will operate in saturation region at the trip point) (10%)

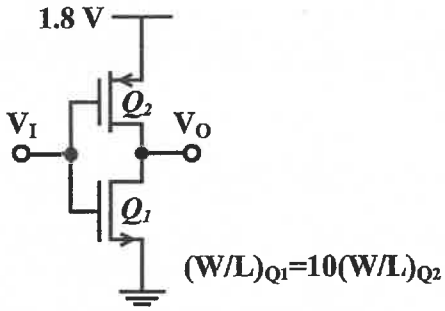


Fig. P7 A CMOS Inverter