### IEE 6736 Analog ICs (II) 期末考试 — 6/9/2003

Name:

Student ID Number:

注意事項:
- 不作弊，也不幫助他人作弊。否則須受任何懲罰。
- 可以帶兩張 A4 紙之筆記。不可以在書或其他筆記。
- 試卷總共有 5 頁。請馬上檢查！
- 考題總共有 4 項。總分是 100 分。
- 考試時間有 100 分鐘。
- 可以用中文或英文作答。答案請寫清楚。
- 答案直接寫在試卷上。試卷背頁也可以寫。如果寫在背頁，請在正頁註明，以免被漏看。
- $G = 10^9, M = 10^6, k = 10^3, m = 10^{-3}, \mu = 10^{-6}, n = 10^{-9}, p = 10^{-12}, f = 10^{-15}$.

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1. 20 Points
Consider the $G_m$-C filter shown below. Assume the transconductors are ideal, and $C_A = 2$ pF.

a. [10 pts] Find the transfer function $H(s) = V_o(s)/V_i(s)$ in terms of $G_{m1}$, $G_{m2}$, $C_x$, and $C_A$.

b. [10 pts] Find $G_{m1}$, $G_{m2}$, and $C_x$, so that the filter has a dc gain of 1, a pole at $-50$ MHz, and a zero at $-100$ MHz.
2. 30 Points
Consider the switched-capacitor filter shown below. Assume both opamp and switched are ideal, and clock frequency \( f_s = 1 \text{ MHz} \). Want to use this switched-capacitor circuit to approximate a s-domain first-order low-pass filter with a pole at \(-100 \text{ kHz}\), a zero at \(-200 \text{ kHz}\), and a dc gain of \(-2\).

a. [15 pts] Find the corresponding z-domain transfer function using bilinear transformation and prewarping.

b. [15 pts] Find the values for \( C_1 \), \( C_2 \), and \( C_3 \). Assume \( C_A = 10 \text{ pF} \).
3. 20 Points
Consider the charge-redistribution DAC shown below. The opamp and the analog switches are ideal, and \( V_R = 1 \) V. The digital input is

\[
D_i = b_2 \times 2^2 + b_1 \times 2^1 + b_0 \times 2^0 \quad b_j \in \{0, 1\} \quad j = 0, 1, 2
\]

a. [8 pts] Sketch the input \( D_i \) to output \( V_o \) transfer function.

b. [5 pts] Sketch the differential nonlinearity (DNL) of the DAC. Assume only \( C_1, C_2, \) and \( C_3 \) are different from their nominal values.

c. [7 pts] Sketch the integral nonlinearity (INL) of the DAC. Let INL = 0 at \( D_i = 0 \) and \( D_i = 7 \).
4. 30 Points
Consider a pipelined ADC consisting of two radix-2 1.5 bit pipeline stages. The characteristic of the pipeline stage is shown below when $G_j = 2$. The input $V_1$ can vary between $-0.5$ V and $+0.5$ V. The output $D_o$ is calculated by

$$D_o = 2 \times D_1 + D_2$$

a. [15 pts] Sketch the $V_1$ input to $D_o$ output transfer function, assuming ideal pipeline stage with $G_1 = 2.0$.

b. [15 pts] Sketch the $V_1$ input to $D_o$ output transfer function, assuming ideal pipeline stage but with $G_1 = 2.5$. 