系所組別：電機工程學系甲乙丁戊組、電腦與通信工程研究所丙丁組、電機資訊學院-微電奈米聯招

考試科目：電子學　　考試日期：0222，節次：1

※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. Fig. 1 shows a circuit that performs the high-pass transfer function.
   (1) Derive the transfer function of this circuit and identify its high-frequency gain and 3-dB frequency. (4%)
   (2) Determine the values of R_1, R_2, and C to obtain a high-frequency input resistance of 10 kΩ, a high-frequency gain of 40 dB, and a 3-dB frequency of 1000 Hz. (6%)
   (3) At what frequency does the magnitude of the transfer function reduce to unity? (4%)

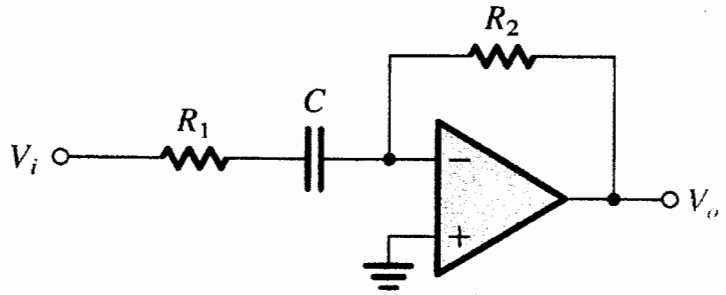

Fig. 1

2. It is required to design the active-loaded differential MOS amplifier of Fig. 2 to obtain a differential gain of 50 V/V. The technology available provides $\mu_n C_{ox} = 4\mu_P C_{ox} = 400\ \mu A/V^2$, $|V_t|=0.5$ V, and $|V_A'|=20V/\mu m$ (channel length modulation effect) and $V_{DD}=V_{SS}= 1V$. Use a bias current I=200μA and operate all devices at $|V_{OV}|=0.2V$ (overdrive voltage).
   (1) Find the W/L ratios of the four transistors (Q_1, Q_2, Q_3, and Q_4). (4%)
   (2) Specify the channel length required of all transistors. (4%)
   (3) If I is delivered by a simple NMOS current source operated at the same V_{OV}, for $V_{CM}=0$, what is the allowable range of v_o? (4%)

(背面仍有題目,請繼續作答)

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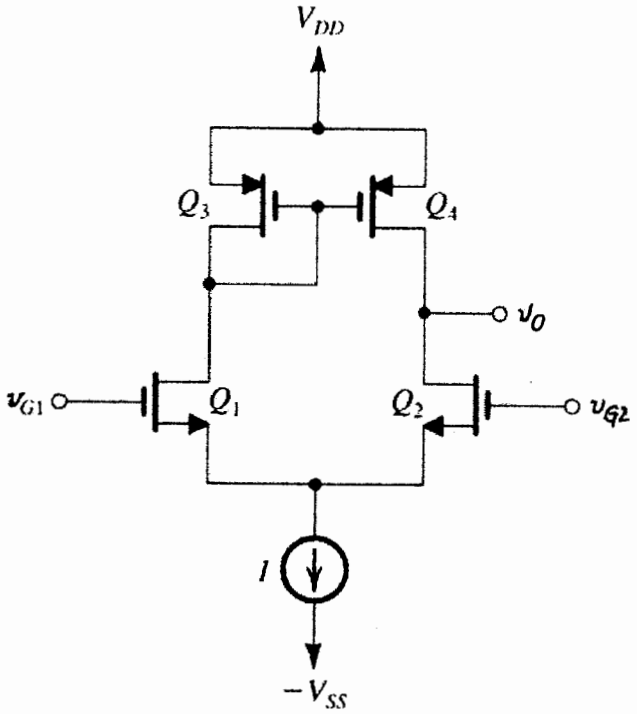

Fig. 2

3. The open-loop gain of an amplifier has break frequencies at f_{p1}=100 kHz, f_{p2}=200 kHz, and f_{p3}=1 MHz. The low-frequency (or DC) gain is A_o=800, and the feedback factor is β=0.5. Please calculate
   (1) The gain crossover frequency. (4%)
   (2) The phase margin. (4%)

4. An amplifier with open-loop voltage gain of 10^4 and poles at 10^3 Hz, 10^5 Hz, and 10^6 Hz is to be compensated by the addition of a dominant pole to operate stably with a closed-loop gain of 30 dB with a 45° phase margin, what new pole frequency should be used? (6%)

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5. (1) A second-order filter has the transfer function

$$T(S) = \frac{1}{S^2 + (10 + \alpha)S + 25}$$

Find the range of α for which the filter can operate stably? (4%)

(2) What type of this filter can be realized as the following transfer function? Explain why? (8%)

$$T(S) = \frac{S(S^2 + 0.01)(S^2 + 4)}{(S^2 + 0.8S + 0.52)(S^2 + 0.56S + 0.18)(S^2 + 0.56S + 0.86)}$$

6. A waveform generator circuit is shown in Fig. 6. If the op amps have saturation voltages of ± 10 V, given C = 0.01 m F, R_1 = 10 kΩ, R_2 = 20 kΩ, and R = 50 kΩ.

(1) Sketch and label the waveforms v_1 and v_2. (10%)

(2) Determine the frequency of waveform v_1. (5%)

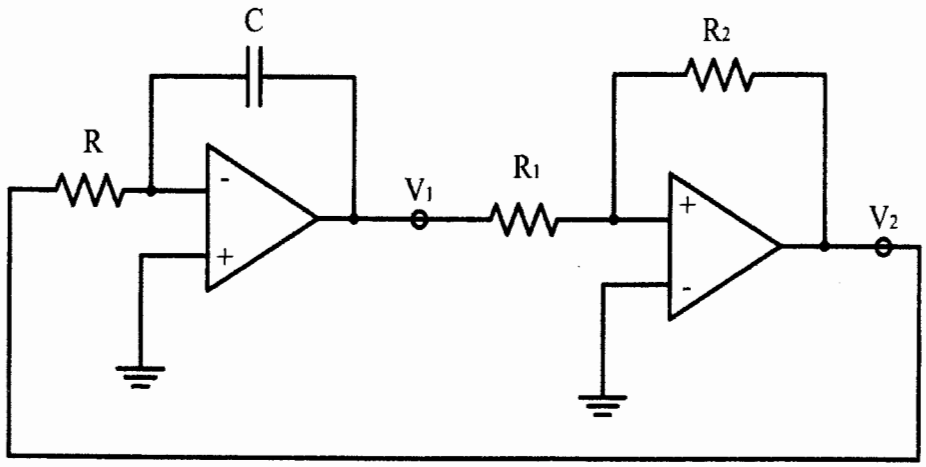

Fig. 6

7. Consider the circuit shown in Fig. 7 with parameters of $v_I = 5 \times \sin(\omega t)$ volts where $\omega = 2000\pi$ radians/sec, $C_1 = C_2 = 1\mu F$ and uncharged initially, the cut-in voltage of both diodes V_γ while the forward diode resistance $r_f = 0\Omega$, reverse breakdown voltage = 100 V, saturation current = 2.5×10^{-9} A.

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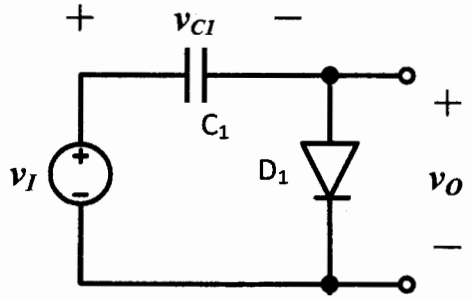
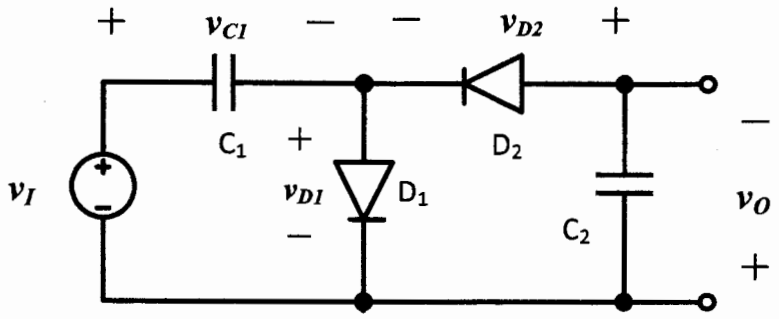
(1) What are the maximum and minimum voltage of v_O when $V_\gamma = 0$ for Fig. 7(a)? (4%)

(2) Assume $V_\gamma = 0$ for Fig. 7(a). Sketch waveforms of v_{C1} and v_O along with v_I starting from $t = 0$ sec to 3 ms. (10%)

(3) Assume $V_\gamma = 0.7$ V for Fig. 7(b). What are the maximum and minimum voltage of v_O? (4%)



(a)



(b)

Fig. 7

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8. Consider the circuit shown in Fig. 8 with parameters of V_{DD}=5 V, $\mu_n C_{ox}$= 40 μ A/V^2, and $\mu_p C_{ox}$=20 μ A/V^2, V_{tn}=|V_{tp}|=1V, $(W/L)_{Q1} = (W/L)_{Q3} = 2\,\mu m/1\,\mu m$, $(W/L)_{Q2} = (W/L)_{Q4} = 4 \times (W/L)_{Q1}$, $(W/L)_{Q5} = (W/L)_{Q6} = (W/L)_{Q7} = (W/L)_{Q8}$.
Note that B and $\overline{B}$ are outputs while *Set*, *Reset*, and *Clk* are inputs. *Clk* is the clock signal. *Set* and *Reset* are complementary signals, i.e., when *Set* = V_{DD}, Reset = 0; vice versa.

(1) Determine the minimum W/L for both Q_5 and Q_6 required to ensure that the two back-to-back inverters of the circuit will switch at half of V_{DD} when inputs Set and Clk are V_{DD}. (7%)

(2) Find the minimum W/L for both Q_5 and Q_6 such that switching is achieved when inputs Set and Clk are half of V_{DD}. (8%)

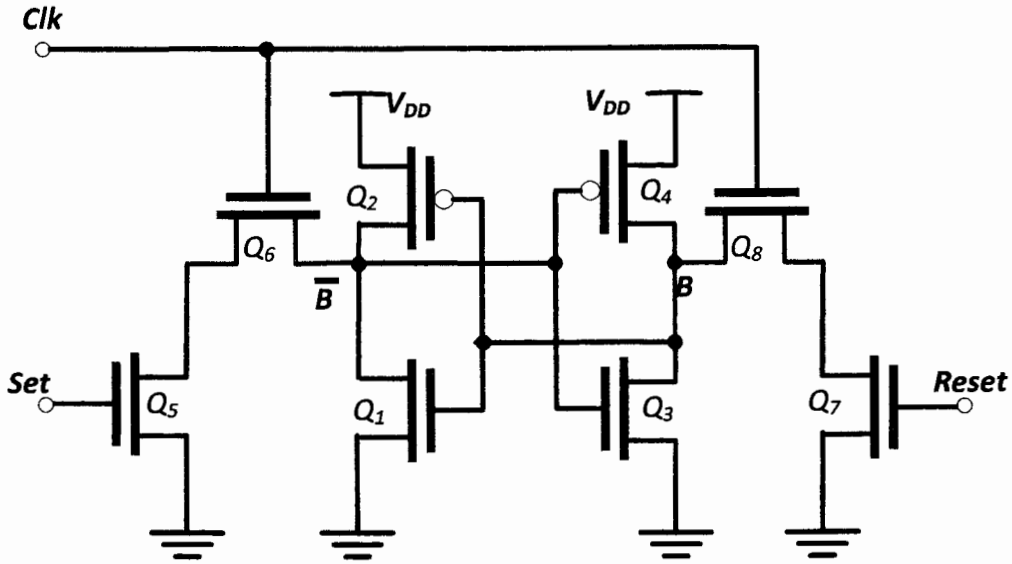

Fig. 8