國立中央大學九十一學年度碩士班研究生入學試題卷

1. 選擇題(15 分, 答錯每題倒扣 1 分)

For the circuit shown in Fig. 1, let R_C = 3 kΩ, R_E = 1 kΩ, β_F = 100, $V_{BE(on)}$ = 0.7 V, $V_{CE(sat)}$ = 0.3 V, and Early voltage V_A = ∞. Four bias conditions are available: (A) R_1 = 50 kΩ, and R_2 = 50 kΩ (B) R_1 = 80 k KΩ, R_2 = 20 kΩ, (C) R_1 = 20 kΩ, R_2 = 80 kΩ, and (D) R_1 = 70 kΩ, R_2 = 30 kΩ.

(1) Which bias condition(s) could be chosen such that this circuit could be used as a voltage amplifier. (5 分, 複選)

(2) Which bias condition could provide the maximum allowable output signal swing for a voltage amplifier? (5 分)

(3) Which bias condition(s) could be chosen such that this BJT is operated in saturation region. (5 分, 複選題)

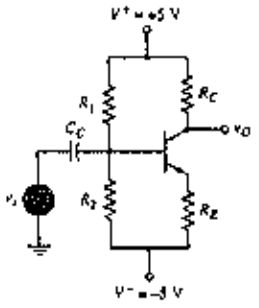
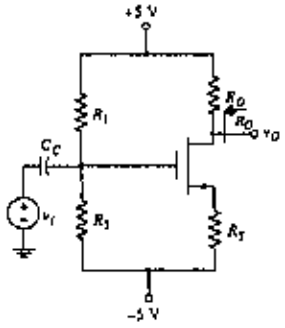
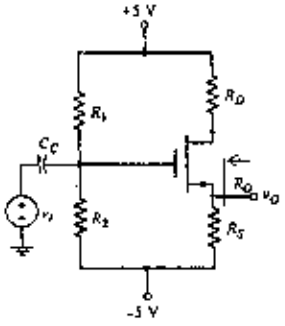


Fig. 1



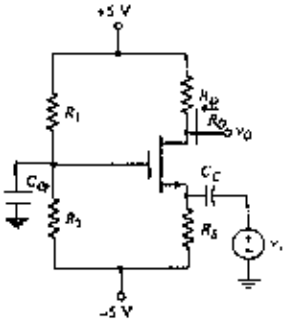
configuration A

Fig. 2(A)



configuration B

Fig. 2(B)



configuration C

Fig. 2(C)

2. (15 分, 答錯倒扣 3 分)

For the circuits shown in Fig.2, let R_1 = 600 kΩ, R_2 = 400 kΩ, R_D = 5 kΩ, and R_S = 1 kΩ, $\mu_n C_{ox}$ = 100 μA/V², $(W/L)_n$ = 2.5 μm/1 μm, V_{TH} = 1 V, and V_A = ∞, such that the MOSFET is biased to have a drain current I_D = 1 mA. Consider three amplifier configurations A, B, and C as shown in Fig. 2(A), 2(B), and 2(C), respectively.

(1) Which configuration could provide the maximum voltage gain $A_v = v_o/v_i$? (3 分) Please specify the value of A_v. (5 分)

(2) Which configuration could provide the minimum output resistance? (3 分) Please specify the value of R_o. (4 分)

3. (15 分)

For the op-amp phase-shifter circuit as shown in Fig. 3

(1) derive the transfer function $T(s)$ and find the corresponding zero and pole, (9 分)

(2) find the phase-shift at $\omega_0 = 1/RC$, (2 分)

(3) if the input frequency = 10^5 Hz and C = 1.59 nF, calculate the required values of R for phase-shift magnitudes of 30°, 60°, 120°, and 150°. (4 分)

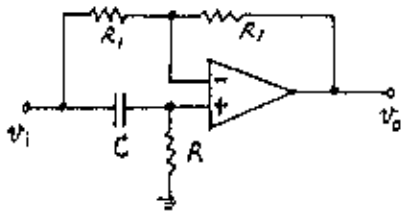


Fig. 3

注意:背面有試題

4. (15 分)

A ring oscillator of 5 inverters is constructed with the basic matched CMOS inverter. The transistor parameters are V_{tn} = -V_{tp} = 0.6 V, $\mu_n C_{ox}$ = 100 μA/V², $\mu_p C_{ox}$ = 40 μA/V², $(W/L)_n$ = 1.2 μm/0.8 μm, $(W/L)_p$ = 3 μm/0.8 μm, C_{ox} = 1.8 fF/μm², C_{gd} = 0.5 fF/μm, and C_{db} = 2.5 fF/μm. C_W is negligible.

(1) If the voltage supply V_{DD} = 3.3 V, estimate the equivalent load capacitance and propagation delay of an inverter stage, and the oscillation frequency of ring-oscillator. (12 分)

(2) If the voltage supply V_{DD} is reduced to 2.0 V, what would you expect the oscillation frequency of ring-oscillator to become? (3 分)

5. 選擇題(15 分，答錯每題倒扣 1 分)

Consider three amplifiers A, B, and C as shown in Fig. 5(a), 5(b), and 5(c), respectively. Assume all MOSFETs are operated in saturation region and of the same size, $C_{gs} = 2C_{gd}$, Cx is infinite, $I_1 = I_2 = I_3$, and 1/R is much smaller than MOSFETs' transconductance. Neglect channel length modulation effect and body effect. The gain responses of the three amplifiers are as shown in Fig. 5(d). Let the low frequency voltage gain (Vo/Vi) of the three amplifiers are A1, A2, and A3. The –3dB bandwidth of the three amplifiers are f1, f2, and f3. Which statement is correct?

(1)(5 分) (a) A1 > A2 > A3 (b) A3 > A1 > A2 (c) A2 > A3 > A1 (d) A1 > A3 > A2 (e) A1 > A2 = A3.

(2)(5 分) (a) f1 > f2 > f3 (b) f2 = f3 > f1 (c) f2 > f3 > f1 (d) f3 > f2 > f1 (e) f1 > f2 = f3.

(3)(5 分) Adjust I_1, I_2, and I_3 such that the three amplifiers have the same voltage gain. In this case, assume all MOSFETs are operated in saturation region, which amplifier has the lowest DC power consumption?
(a) Amplifier A (b) Amplifier B (c) Amplifier C.

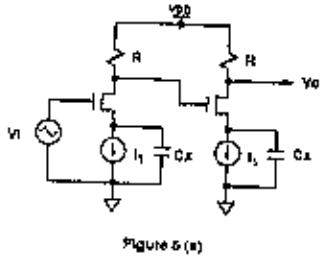


Figure 5 (a)

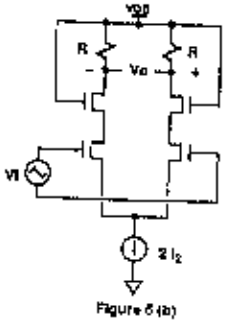


Figure 5 (b)

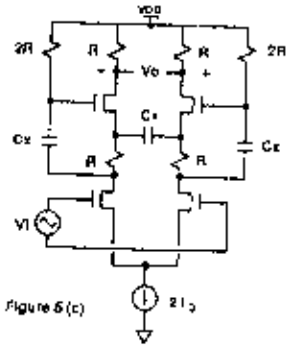


Figure 5 (c)

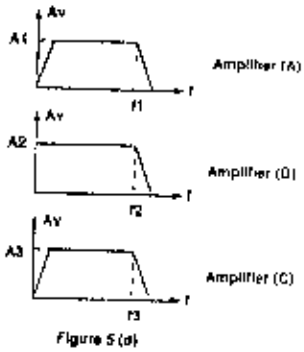


Figure 5 (d)

6. (25 分，答錯每題倒扣 1 分)

Consider three circuits as shown in Fig. 6. Assume OPA is an ideal operational amplifier (gain = ∞), the saturation voltage of OP is 10 V and 0 V, $V_{tn} = |V_{tp}| = 1$ V, $\mu_n C_{ox}(W/L)_{M1} = \mu_p C_{ox}(W/L)_{M2} = \mu_n C_{ox}(W/L)_{M3} = 8$ mA/V^2, Vi = 4 V.

(1) (5 分) Which statement could be correct? (a) Vo1 = Vo3 (b) Vo2 = Vo3 (c) Vo1 = Vo2

(2) (5 分) What kind of feedback is utilized in amplifier Fig. 6(b)?
(a) shunt-shunt (b) series-shunt (c) shunt-series (d) series-series

(3) (5 分) What kind of feedback is utilized in Fig. 6(c)?
(a) shunt-shunt (b) series-shunt (c) shunt-series (d) series-series

(4) (5 分) Vx = ? (a) 4 V (b) 5 V (c) 6 V (d) 7 V (e) 3 V

(5) (5 分) If OPA gain = 100, g_{m3} is the transconductance of M3. In Fig. 6(c), to increase the output impedance Ro by adjusting W/L of M3, which approach could be useful?
(a) reduce the channel length of M3 while keeping g_{m3} unchanged (b) reduce the channel width of M3 while keeping the channel length unchanged (c) increase the channel width of M3 while keeping channel length unchanged.

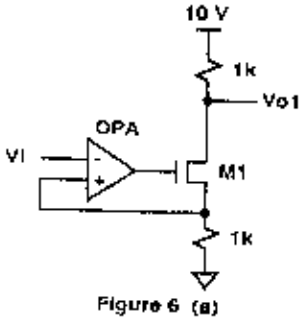


Figure 6 (a)

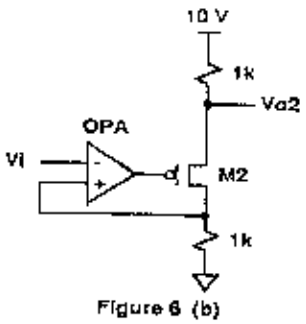


Figure 6 (b)

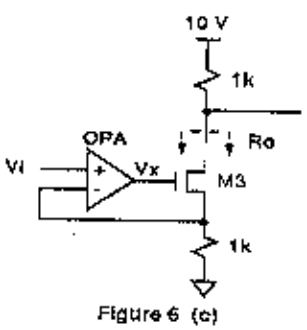


Figure 6 (c)