大同大學 九十一 學年度研究所碩士班入學考試試題

考試科目：電子學　　所別：電機工程研究所　　第 1/2 頁

註：本次考試 不可以參考自己的書籍及筆記； 不可以使用字典； 可以使用計算器。

1. The ideal metal-oxide-semiconductor structure is shown in Fig. P1, the doping concentration (in $p-$Si)$=N_A$, the oxide thickness$=x_o$, the depletion width(in $p-$Si)$=x_d$, ε_s (permittivity of Si)$=11.7\,\varepsilon_0$ and ε_{ox} (permittivity of oxide)$=3.9\,\varepsilon_0$.

   4%(a) Derive the electric field $E(x)$ in the region $0 \le x \le x_d$ for the depletion case(V_G>0).

   4%(b) Find an expression for electric field(E_{ox}) in the oxide in terms of N_A and x_d etc..

   2%(c) Sketch the $E(x)$ vs x plot over the region $-x_o \le x \le x_d$.

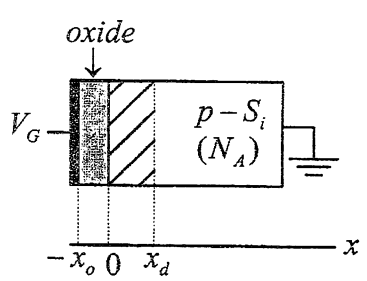


Fig. P1

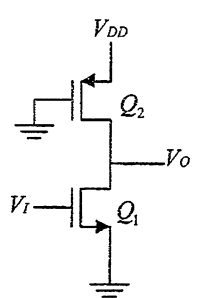


Fig. P2

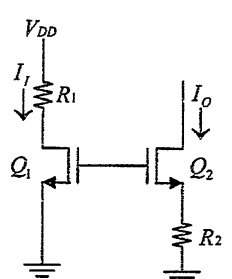
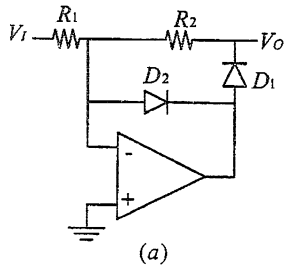


Fig. P3

2. (10%)Refer to Fig. P2, $V_{DD}=5V$, MOS threshold voltage $V_t=V_{tn}=-V_{tp}$=1V, $K_r=\dfrac{K_n}{K_p}=9$, where $K_{n,p}=(\mu C_{ox}{}^{W}\!/_{L})_{n,p}$. The gate threshold voltage V_M is by definition the value of V_I for which $V_O=V_I$. (a)Derive V_M in terms of V_t, V_{DD} and K_r. (b)Calculate V_M.

3. (10%)Refer to Fig. P3, both transistors operate in saturation region, $I_I=0.1mA$, $R_2=4K\Omega$, $\mu_n C_{ox}\dfrac{W}{L}={}^{5mA}\!/_{V^2}$, and $V_{tn1}=V_{tn2}$. Neglect the body effect and channel length modulation, calculate I_O.

4. (8%)Refer to Fig. P4 (a) and (b), derive the relationship between V_O and V_I, sketch V_O vs V_I plot.



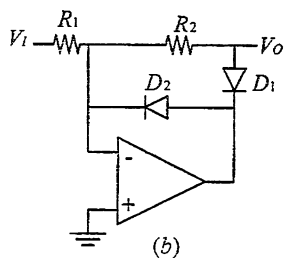


Fig. P4

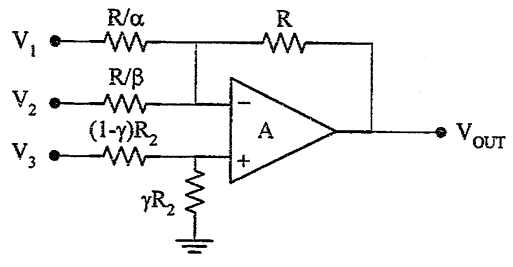


Fig. P5

5. (8%) Consider the circuit shown in Fig.P5, where α,β and γ are constants and 0≤γ≤1. If the gain of the opamp is finite and denoted by A, write the output function.

(22%)

6. (a)Consider the circuit shown in Fig.P6(a), estimate the midband gain and the upper –3dBfrequency. ($\mu_n C_{ox}(W/L)$=400μA/V^2, V_{tn}=0.7V, C_{gs}=0.2pF and C_{gd}=50fF)

   (b)The bias current I_B in the circuit shown in Fig.P6(b) is the same as that in Fig.P6(a). If the midband gain of the circuit in Fig.P6(a) is denoted by K, what is the low-frequency gain of the circuit shown in Fig.P6(b). Also estimate its upper –3dB frequency.

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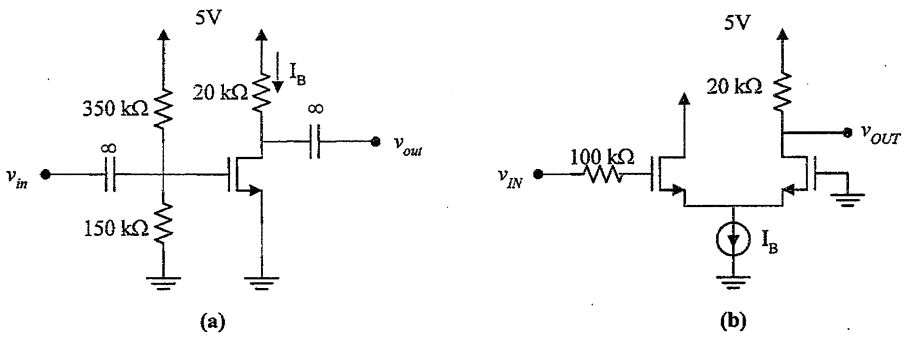

Fig.P6

7. (12%) Consider the circuit shown in Fig.P7, where $\mu_n C_{ox}=2.5\times\mu_p C_{ox}=100\mu A/V^2$, $V_{tn}=-V_{tp}=0.7V$, $(W/L)_1=(W/L)_3=(W/L)_4=8$, $(W/L)_2=32$, and $(W/L)_5=(W/L)_6=(W/L)_7=20$.
   (a)If all the transistor are operating in the saturation region with $I_{out}=100\mu A$, find the required resistance R_S. (Neglect the channel-length modulation and body effects.)
   (b)Estimate the output resistance (R_{out}) seen into the drain of transistor M4.($\lambda=0.025\ V^{-1}$)

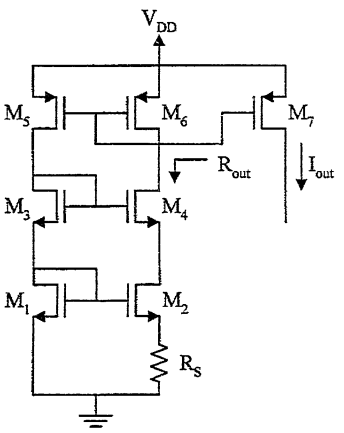

Fig.P7

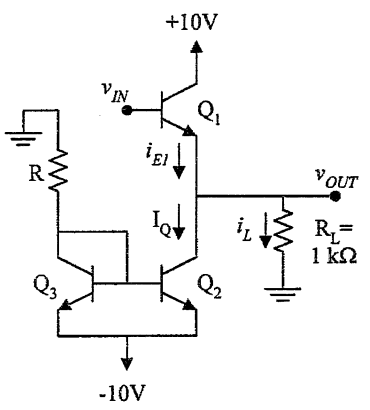

Fig.P8

8.(12%) A class-A emitter follower biased with a constant-current source is shown in Fig.P8, where the transistors parameters are $\beta=100$, $V_{BE}=0.7V$ and $V_{CE(sat)}=0.2V$.
   (a)What is the maximum and minimum values for i_L?
   (b)What is the minimum value for I_Q? Determine the value of R to produce the corresponding current.

9.(8%) The open-loop gain of an amplifier is given by $A(s)=\dfrac{1000}{(1+\dfrac{s}{\omega_b})^3}$. The amplifier is placed in a negative-feedback loop with transfer function β, a real constant. Find the maximum value of β for the amplifier to be stable.