招生學年度	105	招生類別	碩士班
系所班別	電機工程學系碩士班		
科目名稱	電子學		
注意事項	本考科可使用掌上型計算機		

1. (10 分) Electrons are being steadily injected into a region of *p*-type silicon. In the steady state, the excess electron concentration profile shown in Fig. P1 is established in the *p*-type silicon region. If $N_A = 10^{16}$ cm^{-3}, $n_i = 1.5\times10^{10}$ cm^{-3}, and $W = 5$ μm, find the current density that will flow in the *x* direction. Hint: $D_n = 34$ cm^2/s and $D_p = 12$ cm^2/s.
2. (10 分) Sketch the physical structure of a NMOS transistor. Indicate the source, drain, gate, oxide, body, and channel while the transistor is turned-on.
3. (15 分) For the NMOS amplifier in Fig. P3, replace the transistor with its T equivalent circuit. Derive expressions for the voltage gains v_s/v_i and v_d/v_i. Hint: Neglect the Early effect.
4. (15 分) For the emitter-follower circuit shown in Fig. P4, the BJT has $\beta = 100$. Assume $V_{BE} = 0.7$ V. Find (a) I_E, V_E, and V_B, (b) the input resistance R_{in}, and (c) the voltage gain v_o/v_{sig}.

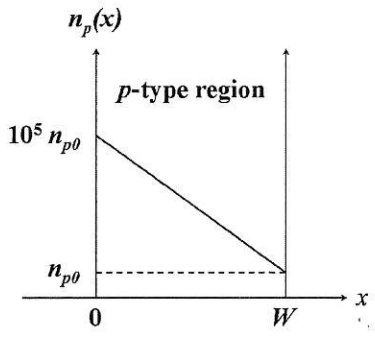

Fig. P1

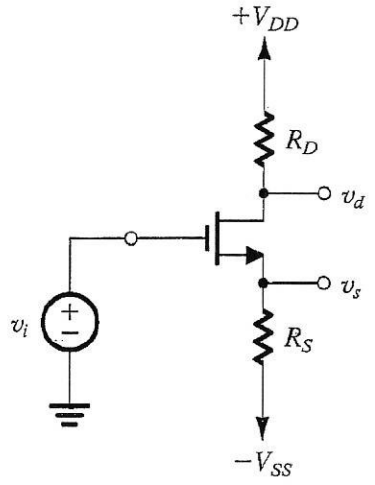

Fig. P3

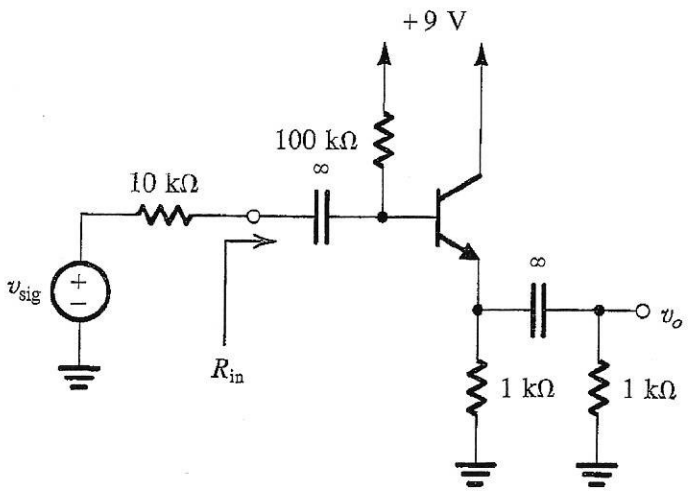

Fig. P4

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5. (20 分) Estimate the Gm and voltage gain of the differential amplifier as shown in Fig. P5. Notice that V_{DD}=3V, I_B=50μA, Vt=1V, $(W/L)_{N1}=(W/L)_{N2}$=100 $(W/L)_{P1}=(W/L)_{P2}$=200, μnCox=200μA/V^2, μpCox=100μA/V^2, $V_{AN}=|V_{AP}|$=20V.

6. (20 分) Two amplifiers are connected in series and with midband gain of A1 and A2 (Fig. P6). Their high-frequency dominant poles are ω1 and ω2, respectively. Answer the following questions.
   (a) Find the high frequency response for H(s)=Vo(s)/Vi(s) of the system.
   (b) If ω1 << ω2, please depict the Bode plot of H(s) for ωin the range of 0.1ω1<ω2<10ω2.

7. (10 分) Fig. P7 shows a feedback amplifier with three BJTs, Q1, Q2, Q3. Notice that currents on BJTs are I_{C1}=0.5mA, I_{C2}=1mA and I_{C3}=5mA. Also β is assumed 100 and $r_o=\infty$. Please calculate the closed-loop voltage gain which is defined as $A_f \equiv$ Vo/Vi.

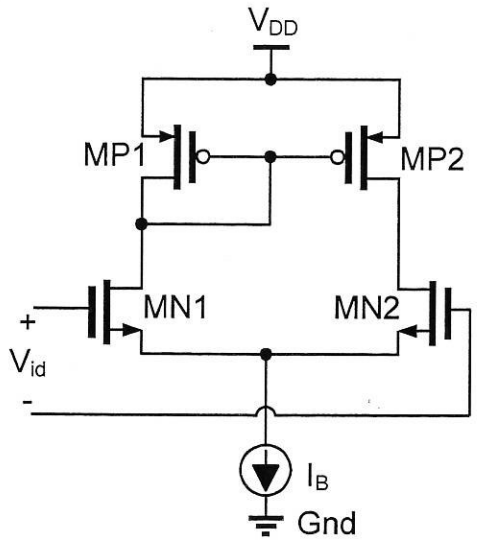

Fig. P5 Differential amplifier with active load.

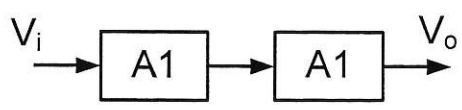

Fig. P6

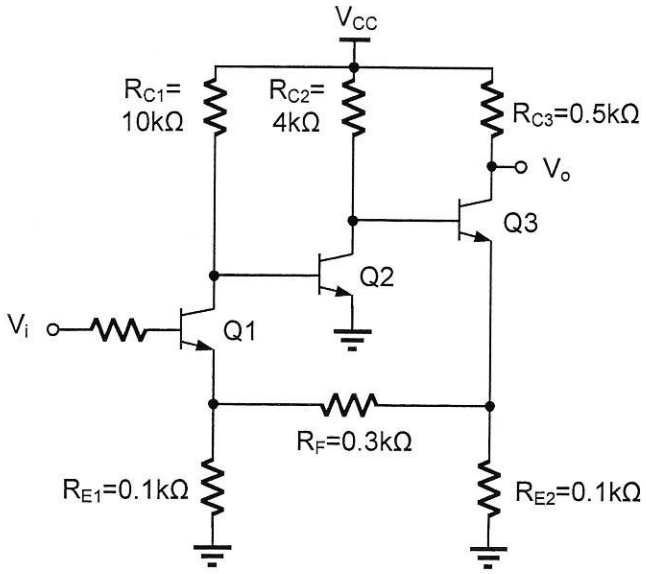

Fig. P7 Feedback amplifier.