八十五學年度電機工程學系（所）＿＿＿＿組碩士班研究生入學考試

科目 電子學 科號 3809 共 3 頁第 1 頁 *請在試卷【答案卷】內作答

1. Sketch the cross section of a standard bipolar junction transistor (BJT). To obtain a BJT of high current gain (β), what should be done in the device structure ?(10%)
2. Does any internal current exist for the open-circuit PN junction ? Why ? (7%)
3. Sketch the basic BiCMOS logic inverter and describe its characteristic (10%)
4. Sketch the cross section of a double-diffused (DMOS) power MOSFET and describe its operation. (10%)
5. Derive the barrier voltage (built-in voltage) Vo of a PN junction with doping concentration in N-type N_D, doping concentration in P-type N_A, thermal voltage V_T, and intrinsic concentration n_i. (hint: starting with $J = q\mu_p p\varepsilon - qD_p\frac{dP}{dx}$)(13%)
6. For the logic diagram of Fig.6, draw the waveforms for the clock pulse, Q_0, Q_1, Q_2, and Q_3 (starting with 0000). This system is a N:1 counter. What is N ? (13%)

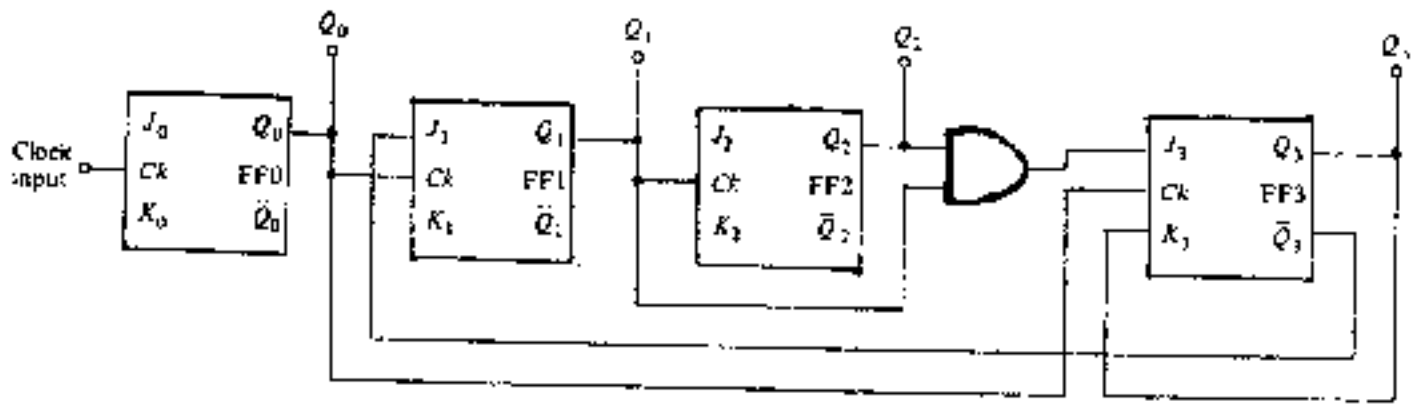

Fig.6

7. For the circuit of Fig.7, sketch the transfer characteristic Vo-Vi. The diodes have a constant 0.7-V drop when conducting. (7%)

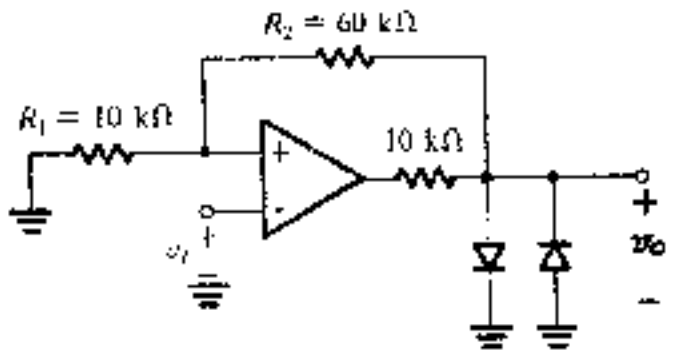

Fig.7

8. Analyze the high-frequency response of the CMOS amplifier shown in Fig.8. The dc bias current is 10 μ A. For Q1, $\mu_n C_{ox}$= 20 μ A/V^2, V_A= 50 V, W/L=64, and Cgs=Cgd= 1 pF. For Q2, Cgd = 1 pF and V_A = 50 V. There is a 1-pF stray capacitance between the common drain connection and ground. Assume that the resistance of the input signal generator is negligibly small and the signal voltage at the gate of Q2 is zero. Find the frequency of the pole and zero. (15%)

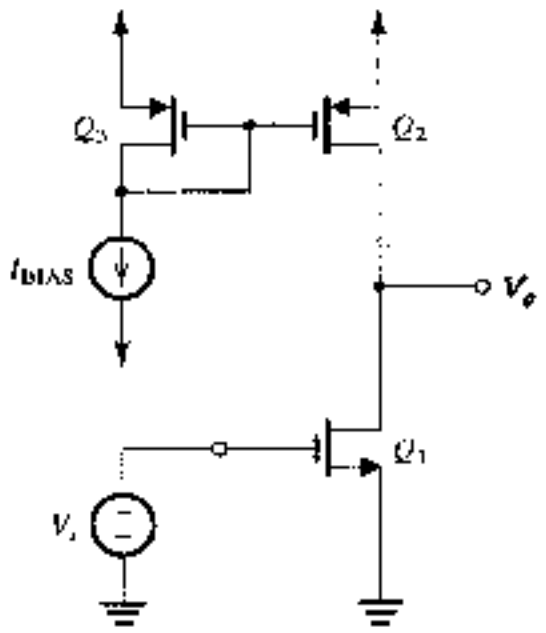

Fig 8

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9. For the circuit of Fig.9, $|V_t| = 1$ V, $K = 0.5$ mA/V^2, $h_{fe} = 100$, and the Early voltage magnitude for all devices (including those that implement the current source) is 100 V. The signal source Vs has a zero dc component. Find the dc voltage at the output and at the base of Q_3. Find the values of A, β, A_f, R'_{if}, and R'_{of}. (15%)

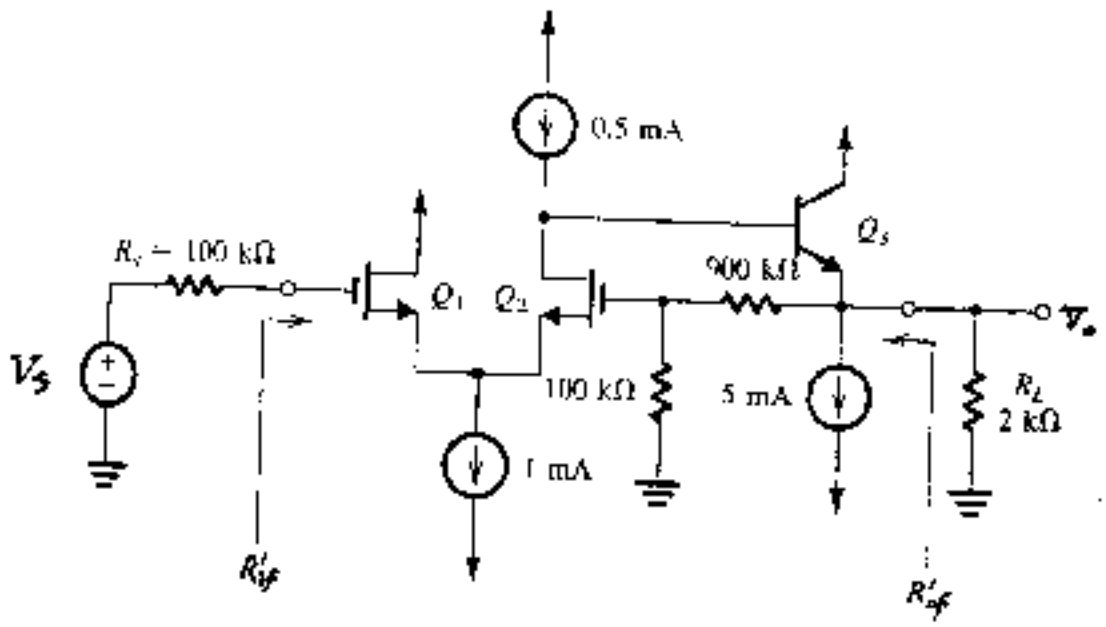

Fig.9