1. A drift current density of 120 A/cm^2 is established in n-type GaAs with an applied electric field of E = 12 V/cm. Determine the resistivity of the semiconductor. (5%)
2. As the circuit shown in Fig. 1. Let the cut-in voltage $V_r = 0$. Plot the v_O versus v_I over the range $-10 \leq v_I \leq +10$V. (5%)

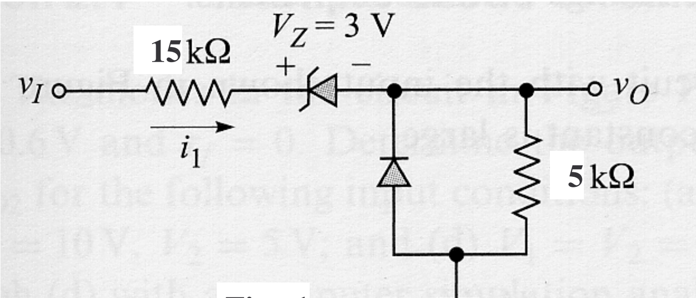

Fig. 1

3. Calculate the small-signal (1) input resistance R_{ib}, (2) output resistance R_o and (3) voltage gain $A_V = v_O/v_I$ as shown in Fig. 2. Let: $\beta = 100$ and $V_A = \infty$. (15%)

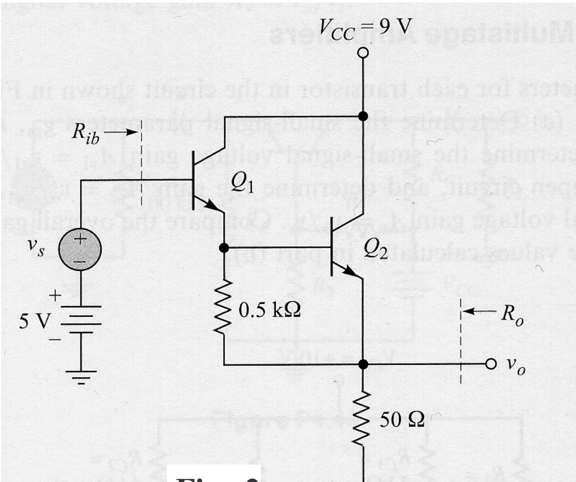

Fig. 2

4. As the circuit shown in Fig. 3, let $\mu_n C_{ox}(W/L) = 2$ mA/V^2, $V_{TN} = 2$ V, $\lambda = 0$, $C_{gs} = 5$ pF, and $C_{gd} = 1$ pF. Find (1) the equivalent Miller capacitance and (2) the upper 3 dB frequency. (15%)

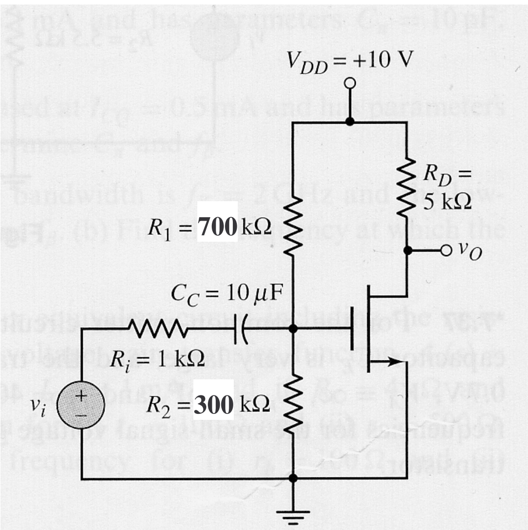

Fig. 3

5. Derive the differential voltage gain (v_o/v_d) of the circuit as shown in Fig. 4. (10%)

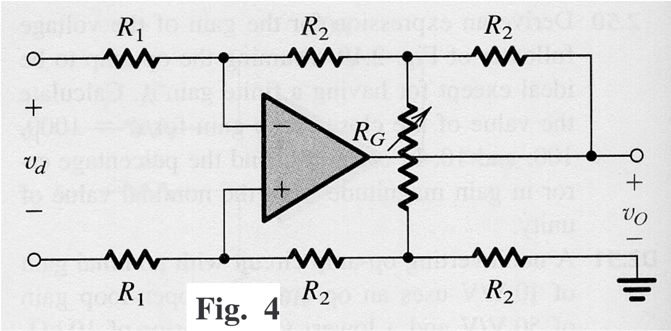

Fig. 4

6. Determine the logic function at the output Y of the circuit as shown in Fig. 5. (10%)

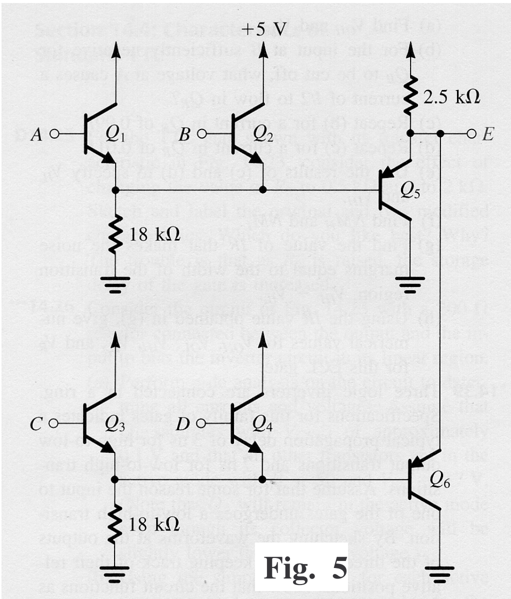

Fig. 5

7. Find the transconductnace transfer function $A_g = i_o/v_s$ of the circuit shown in Fig. 6. Assume that $h_{FE} = 100$, $V_{BE}(\text{on}) = 0.7$ V, and $V_A = \infty$. (20%)

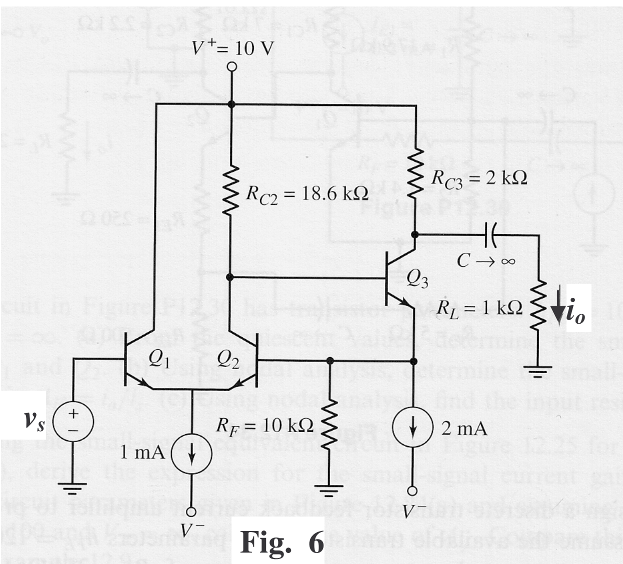

Fig. 6

8. For the circuit shown in Fig. 7. Let $V_{TN1} = V_{TN2} = 2$ V, $\mu_n C_{ox}(W/L)_1 = \mu_n C_{ox}(W/L)_2 = 8$ mA/V^2, and $\lambda_1 = \lambda_2 = 0$. Find (1) the transconductnace g_m of transistor M$_1$, (2) the Q-point drain current of M$_2$ and (3) the overall small-signal voltage gain $A_V = v_O/v_i$.　(20%)

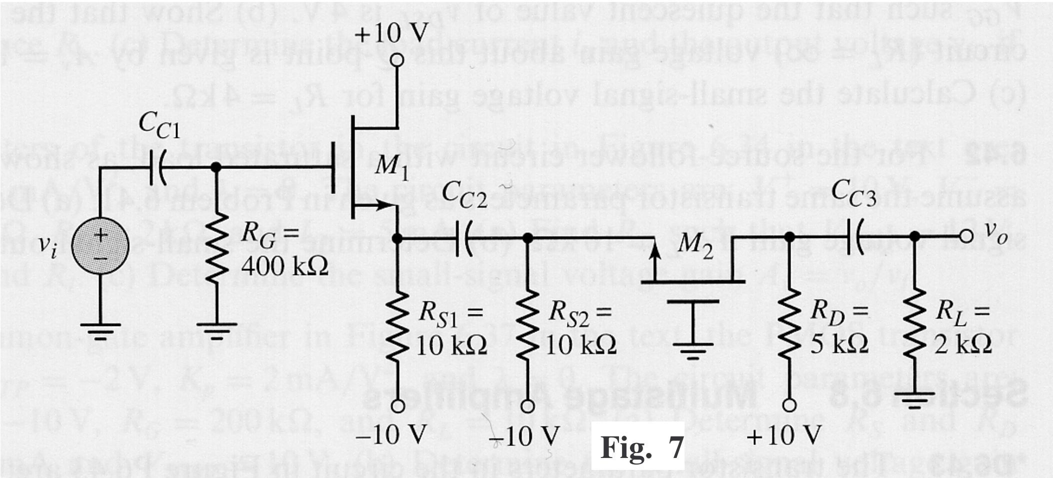

Fig. 7