7.3 Find the intrinsic gain of an NMOS transistor fabricated in a process for which \( k_n' = 200 \, \mu \text{A/V}^2 \) and \( V_A' = 20 \, \text{V/\mu m} \). The transistor has a 0.5-\mu m channel length and is operated at \( V_{OV} = 0.25 \, \text{V} \). If a 2-mA/\text{V} transconductance is required, what must \( I_D \) and \( W \) be?

7.4 An NMOS transistor fabricated in a certain process is found to have an intrinsic gain of 80 \text{V/V} when operated at an \( I_D \) of 100 \mu A. Find the intrinsic gain for \( I_D = 25 \, \mu \text{A} \) and \( I_D = 400 \, \mu \text{A} \). For each of these currents, find the factor by which \( g_m \) changes from its value at \( I_D = 100 \, \mu \text{A} \).

7.5 Consider an NMOS transistor fabricated in a 0.18-\mu m technology for which \( k_n' = 387 \, \mu \text{A/V}^2 \) and \( V_A' = 5 \, \text{V/\mu m} \). It is required to obtain an intrinsic gain of 25 \text{V/V} and a \( g_m \) of 1 \text{mA/V}.

7.9 Using a CMOS technology for which \( k_n' = 200 \, \mu \text{A/V}^2 \) and \( V_A' = 20 \, \text{V/\mu m} \), design a current-source-loaded CS amplifier for operation at \( I = 50 \, \mu \text{A} \) with \( V_{OV} = 0.2 \, \text{V} \). The amplifier is to have an open-circuit voltage gain of \(-100 \, \text{V/V}\). Assume that the current-source load is ideal. Specify \( L \) and \( W/L \).

7.12 Figure P7.12 shows an IC MOS amplifier formed by cascading two common-source stages. Assuming that \( V_{AN} = [V_{AP}] \) and that the biasing current sources have output resistances equal to those of \( Q_1 \) and \( Q_2 \), find an expression for the overall voltage gain in terms of \( g_m \) and \( r_o \) of \( Q_1 \) and \( Q_2 \).

7.13 The NMOS transistor in the circuit of Fig. P7.13 has \( V_s = 0.5 \, \text{V} \), \( k_n' \), \( W/L = 2 \, \text{mA/V}^2 \), and \( V_s = 20 \, \text{V} \).

(a) Neglecting the dc current in the feedback network and the effect of \( r_o \), find \( V_{GS} \). Then find the dc current in the feedback network and \( V_{DS} \). Verify that you were justified in neglecting the current in the feedback network when you found \( V_{GS} \).

(b) Find the small-signal voltage gain, \( \frac{v_o}{v_i} \). What is the peak of the largest output sinewave signal that is possible while the NMOS transistor remains in saturation? What is the corresponding input signal?