1. (a) For the circuit shown in Fig. P1, both junction diodes are identical, conducting i_D = 10 mA at v_D = 0.7 V and i_D = 100 mA at v_D = 0.8 V. Find the value of R for which V = 100 mV.(10%)

   (b) Illustrate the temperature dependence of the diode forward characteristic. (5%)

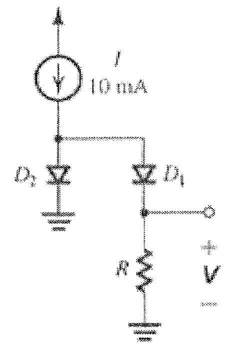

Fig. P1

2. The cascode amplifier shown in Fig. P2 is designed to provide an output swing of 1.9 V with a bias current of 0.5 mA. Assume $(W/L)_{1\text{-}4} = W/L$, and channel-length modulation and body effect are ignored.

   (a) What are the advantages and drawbacks of using a cascode current source? (2%)

   (b) Calculate V_{b1}, V_{b2}, and W/L. (9%)

   (c) What is the voltage gain if L = 0.5 μm? (6%)

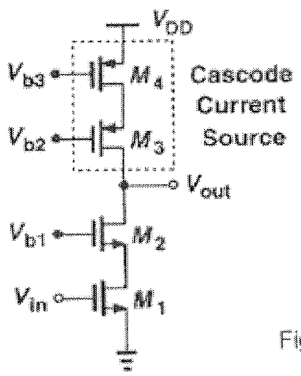

Fig. P2

3. Design a CMOS full-adder circuit with inputs A, B, and C, and two outputs S and C0 such that S is 1 if one or three inputs are 1, and C0 is 1 if two or more inputs are 1. Please sketch your circuit design with proper transistor sizing. Assume that for the basic inverter n = 1.5 and p = 5 and that the channel length is 0.25 μm.(18%)

4. For the NMOS amplifier shown, assume the two capacitors are very large.
   (a) Draw the equivalent circuit with small signal model, (4%)
   (b) Specify the input resistance R_{in}. (3%)
   (c) Specify the output resistance R_{out}. (3%)
   (d) Derive the voltage gains v_o / v_{sig}. (4%)
   (e) Derive the 3-dB frequency f_H. (6%)

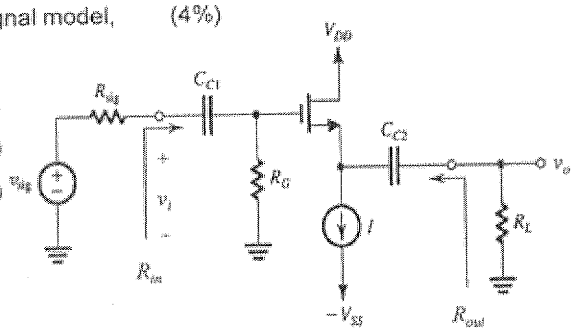

Fig. P4

5. A common-source amplifier with g_m = 2 mA/V, r_o = 50 kΩ, χ = 0.2, and R_L = 50 kΩ has a 500-Ω resistance R_S connected in the source lead.
   (a) Find R_{out}. (3%)
   (b) Determine the open-circuit voltage gain A_{vo}. (4%)
   (c) Determine the voltage gain A_v. (4%)
   (d) Determine the short-circuit trans-conductance G_m. (4%)

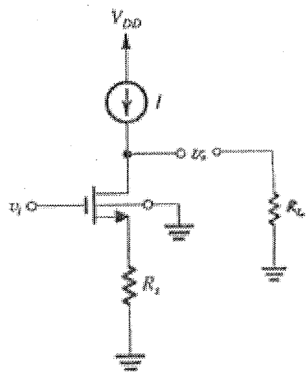

Fig. P5

6. For the following feedback circuit, the op amp has open-loop gain $\mu = 10^4$ V/V, R_{id} = 100 kΩ, and r_o = 1 kΩ.
   (a) Specify the feedback type of the circuit. (3%)
   (b) Calculate the voltage gain v_o/v_s. (4%)
   (c) Calculate the input resistance R_{in}. (4%)
   (d) Calculate the output resistance R_{out}. (4%)

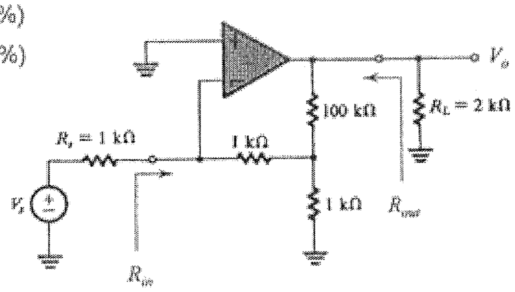

Fig. P6