

1. (a) For the circuit shown in Fig. P1, both junction diodes are identical, conducting  $i_D = 10 \text{ mA}$  at  $v_D = 0.7 \text{ V}$  and  $i_D = 100 \text{ mA}$  at  $v_D = 0.8 \text{ V}$ . Find the value of  $R$  for which  $V = 100 \text{ mV}$ . (10%)  
 (b) Illustrate the temperature dependence of the diode forward characteristic. (5%)

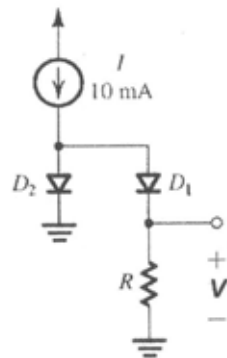


Fig. P1

2. The cascode amplifier shown in Fig. P2 is designed to provide an output swing of  $1.9 \text{ V}$  with a bias current of  $0.5 \text{ mA}$ . Assume  $(W/L)_{1,4} = W/L$ , 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  $L = 0.5 \mu\text{m}$ ? (6%)

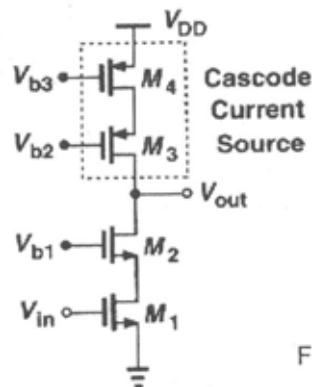


Fig. P2

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  $0.25 \mu\text{m}$ . (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%)

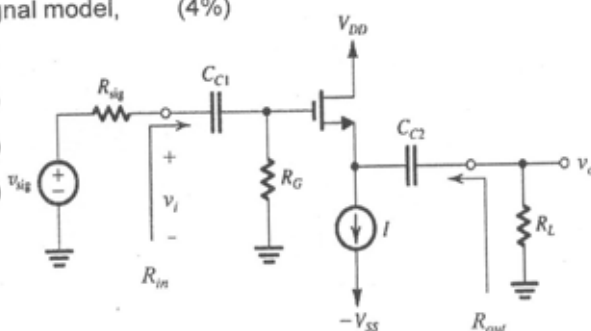


Fig. P4

5. A common-source amplifier with  $g_m = 2 \text{ mA/V}$ ,  $r_o = 50 \text{ k}\Omega$ ,  $\chi = 0.2$ , and  $R_L = 50 \text{ k}\Omega$  has a  $500\text{-}\Omega$  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%)

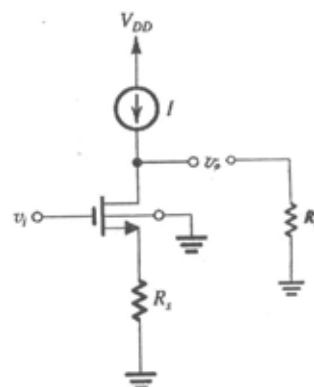


Fig. P5

6. For the following feedback circuit, the op amp has open-loop gain  $\mu = 10^4 \text{ V/V}$ ,  $R_{id} = 100 \text{ k}\Omega$ , and  $r_o = 1 \text{ k}\Omega$ .

- (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%)

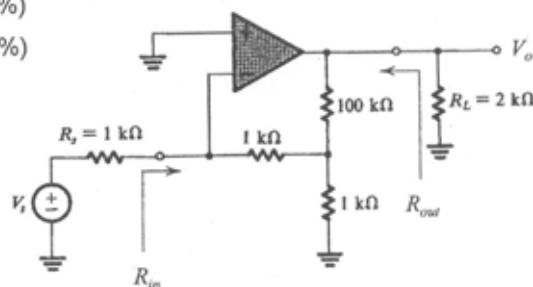


Fig. P6