ShanghaiTech University
School of Information Science and Technology

EE112 Analog Integrated Circuits I

Homework 10

Due: Dec 30th before the recitation

Read the chapter 10.

1. Figure 1 shows a CS amplifier biased by a constant-current source I. Let R_{sig} = 0.5 MΩ, R_G = 2 MΩ, g_m = 3 mA/V, R_D = 20 kΩ, and R_L = 10 kΩ. Find A_M. Also, design the coupling and bypass capacitors to locate the three low-frequency poles at 100 Hz, 10 Hz, and 1 Hz. Use a minimum total capacitance, with the capacitors specified only to a single significant digit. What value of f_L results?

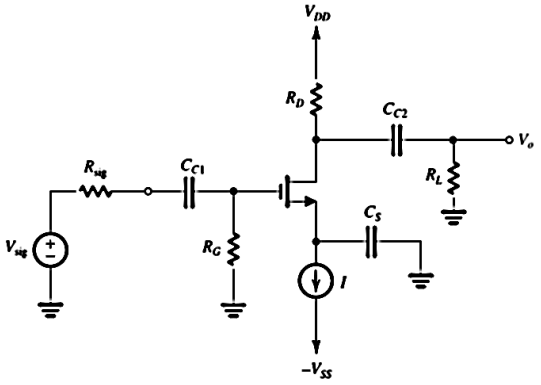

Figure 1

2. Starting from the expression for the MOSFET unity-gain frequency,

$$f_T = \frac{g_m}{2\pi\left(C_{gs} + C_{gd}\right)}$$

and making the approximation that C_{gs} >> C_{gd} and that the overlap component of C_{gs} is negligibly small, show that for an n-channel device

$$f_T \approx \frac{3\mu_n V_{ov}}{4\pi L^2}$$

Observe that for a given channel length, f_T can be increased by operating the MOSFET at a higher overdrive voltage. Evaluate f_T for devices with L = 0.5 μm operated at overdrive voltages of 0.2 V and 0.4 V. Use μ_n = 450 cm^2/V · s.

3. For the discrete-circuit CS amplifier in Fig. 2 let R_{sig} = 100 kΩ, R_{G1} = 47 MΩ, R_{G2} = 10 MΩ, R_S = 2 kΩ, R_D = 4.7 kΩ, R_L = 10 kΩ, g_m = 3 mA/V, r_o = 100 kΩ, C_{gs} = 1 pF, and C_{gd} = 0.2 pF. Find A_M and f_H.

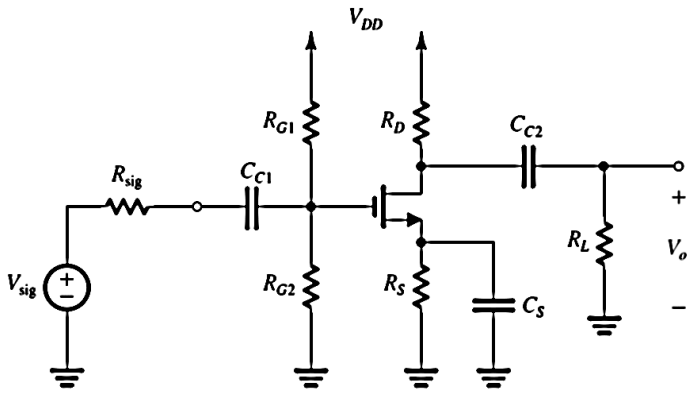

Figure 2

4. Use Miller's theorem to investigate the performance of the inverting op-amp circuit shown in Fig. 3. Assume the op amp to be ideal except for having a finite differential gain, A. Without using any knowledge of op-amp circuit analysis, find R_{in}, V_i, V_o, and V_o/V_{sig}, for each of the following values of A: 10 V/V, 100 V/V, 1000 V/V, and 10,000 V/V. Assume V_{sig} = 1 V. Present your results in the table below.

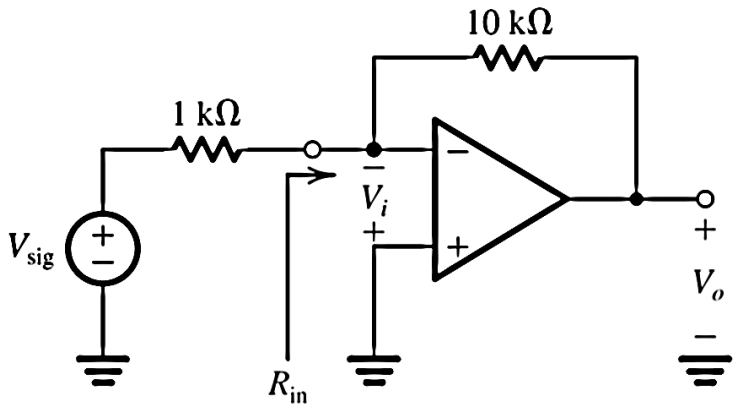

Figure 3

A	R_{in}	V_i	V_o	V_o/V_{sig}
10 V/V				
100 V/V				
1000 V/V				
10,000 V/V				

5. For a particular amplifier modeled by the circuit of Fig. 4, g_m = 5 mA/V, R_{sig} = 150 kΩ, R_G = 0.65 MΩ, R'_L = 10 kΩ, C_{gs} = 2 pF, and C_{gd} = 0.5 pF. There is also a load capacitance of 30 pF. Find the corresponding midband voltage gain, the open-circuit time constants, and an estimate of the 3-dB frequency.

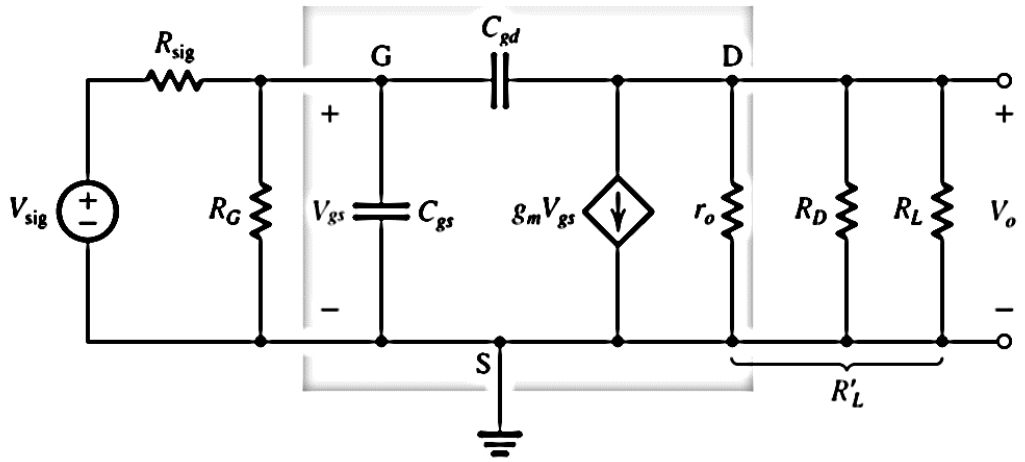

Figure 4