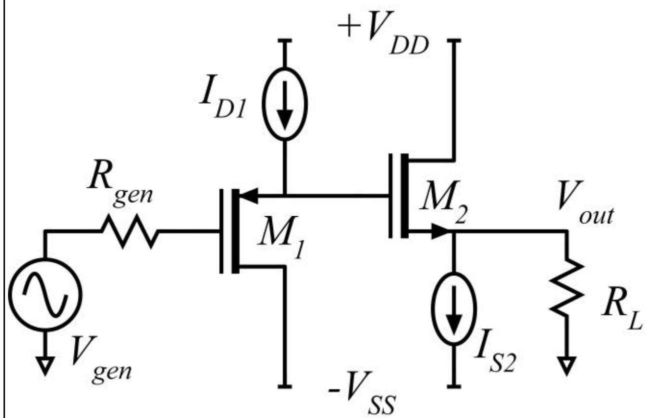
ECE137b problem set 5



The NMOS and PMOS FETs have

$K_\mu = 10\text{mA/V}^2 \cdot (W_g / 1\mu\text{m})$

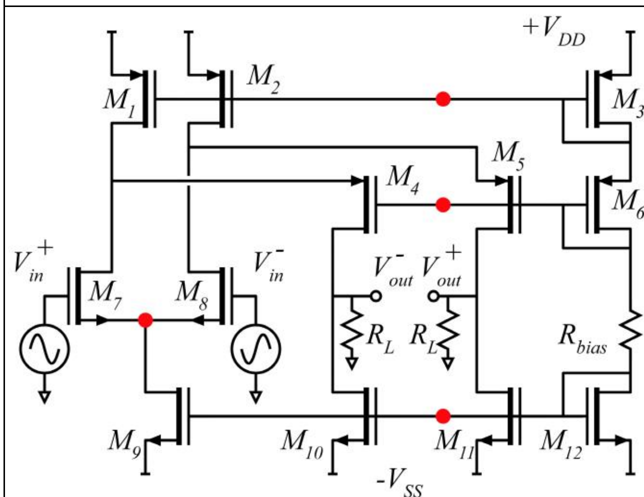
$K_v = 2.0\text{mA/V} \cdot (W_g / 1\mu\text{m})$ $\Delta V = 0.1\text{V}$, $1/\lambda = \infty$

Volts, $|V_{th}|$=0.3 V

$C_{gs} = (1\text{fF}/\mu\text{m}) \cdot W_g$, $C_{gd} = (0.5\text{fF}/\mu\text{m}) \cdot W_g$.

Problem 1: R_{gen} = 1 kΩ, R_L = 100Ω .

The transistors are biased with $I_{D1} = I_{S2}$ = 10 mA, and $|V_{gs}|$=0.4 V. The supplies are +1V and -1V. (a) Find the gate widths and the FET transconductances. (b) find the mid-band value of V_{out}/V_{gen}. (e) find the two zero frequencies in the transfer function (d) Use the method of time constants to find a_1 and a_2. (e) From a_1 and a_2, find the 2 lowest pole frequencies in the transfer function. If the poles are real, find $f_{p1,HF}$ and $f_{p2,HF}$; if they are complex, find $f_n = \omega_n / 2\pi$ and the damping factor ζ. (f) Draw a Bode plot of V_{out}/V_{gen}



Both the NMOS and PMOS FETs have

$K_\mu = 10\text{mA/V}^2 \cdot (W_g / 1\mu\text{m})$

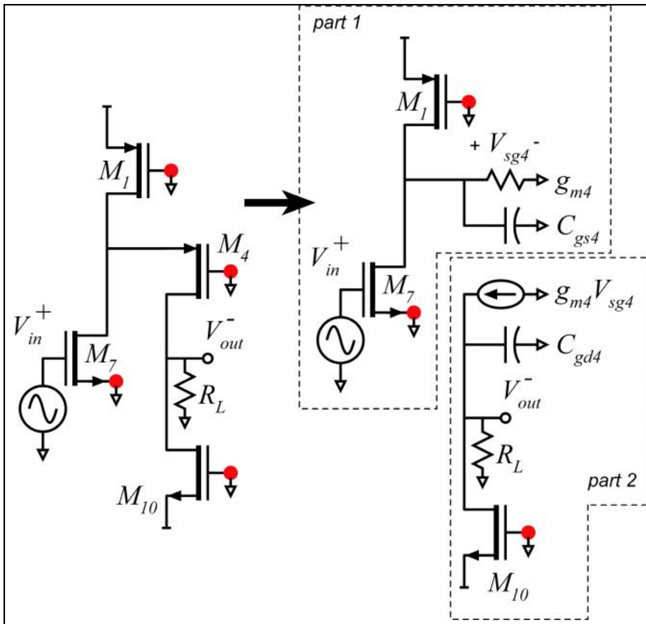
$K_v = 2.0\text{mA/V} \cdot (W_g / 1\mu\text{m})$ $\Delta V = 0.1\text{V}$, $1/\lambda = \infty$

Volts, and a 0.25 V threshold. The gate-source $C_{gs} = (1\text{fF}/\mu\text{m}) \cdot W_g$, $C_{gd} = (0.5\text{fF}/\mu\text{m}) \cdot W_g$

Problem 2:
Choose all FET widths such that $|V_{gs}|$=0.35 V. The drain currents of M7,8 ,4,5,10,11,12= 100 µA
The supplies are +/- 2.0 volts
Q8,7,6 are to be biased at 100 µA
RL=10 kOhm. **SET** $C_{gs7} = C_{gs8} =$ **0 fF.**

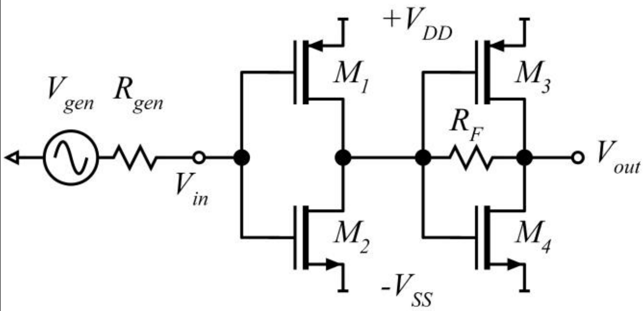
To make the problem much easier to work note that
(1) There are differential inputs, and the red nodes are virtual grounds. So, you can analyze the V_{in}^+, M7, M1, M4, M10, R_L half-circuit.
(2) M4 is a common-gate stage, so the circuit then splits into two separable halves.
These simplifications are shown in the diagrams to the lower left

(a) Find the gate widths and the FET transconductances. (b) find the mid-band value of V_{out}/V_{gen}. (e) find the one zero frequency in the transfer function of part 1 (d) Use the method of time constants



to find a_1 and a_2 of part 1. (e) From a_1 and a_2, find the 2 lowest pole frequencies in the transfer function of part 1. (f) Use the method of time constants to find a_1 of part 2. From this , find the 1 pole frequency in the transfer function of part 2. (g) From these , draw a Bode plot of V_{out}^- / V_{in}^+

Problem 3



The NMOS and PMOS FETs have

$K_\mu = 10\text{mA/V}^2 \cdot (W_g / 1\mu\text{m})$

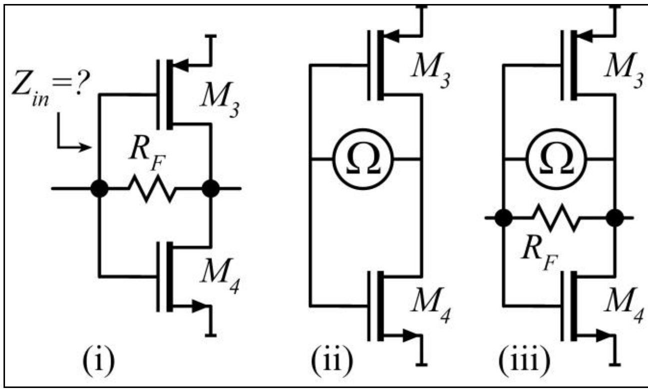
$K_v = 2.0\text{mA/V} \cdot (W_g / 1\mu\text{m})$ $\Delta V = 0.1\text{V}$, $1/\lambda = \infty$ Volts, $|V_{th}|$=0.3 V

$C_{gs} = (1\text{fF}/\mu\text{m}) \cdot W_g$, $C_{gd} = (0.5\text{fF}/\mu\text{m}) \cdot W_g$.

Hints:
You will find the MOTC anlysis easier if you first (i) find the value of Z_{in}, (ii) find the resistance measured by the Ohm meter in this case and (iii) find the resistance measured by the Ohm meter in this case

The supplies are + 0.4V and -0.4V. Choose all FET widths such that they have the same drain currents, and such that each FET has 20 mS transconductance. $R_{gen} = R_F = 100\ \Omega$.

(a) Find the gate widths and drain currents (b) find the mid-band value of V_{out} / V_{gen}; to do this, temporarily set all capacitances and use nodal analysis (e) find the two zero frequencies in the transfer function (d) Use the method of time constants to find a_1 and a_2. (e) From a_1 and a_2, find the 2 lowest pole frequencies in the transfer function. If the poles are real, find $f_{p1,HF}$ and $f_{p2,HF}$; if they are complex, find $f_n = \omega_n / 2\pi$ and the damping factor ζ. (f) Draw a Bode plot of V_{out} / V_{gen}


Z_in=?
M3
R_F
M4
(i)
Ω
M3
M4
(ii)
Ω
M3
R_F
M4
(iii)