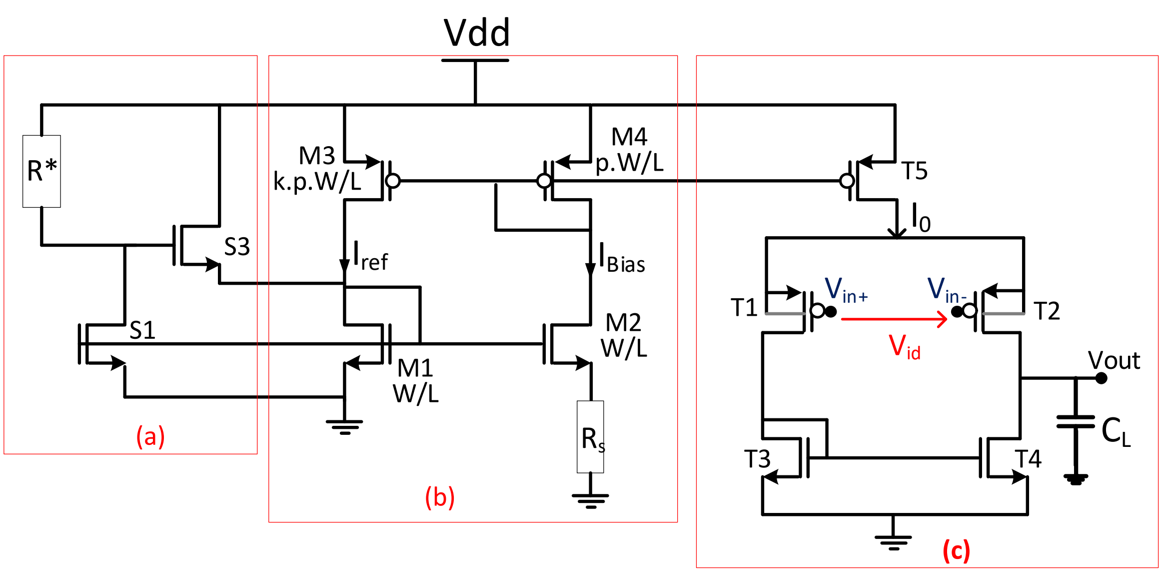
I/gm Design Methodology

EKV Parameters for 1.2V Standard MOST of UMC 65nm technology

Transistor N	Transistor P	
$k_{P,n}$= 300 µA/V^2 n= 1.2 V_{T0}= 0.4 V $U_{a,N}$= 10 V/µm C_{ox}= 13 fF/µm^2 $C_{gs,ov} = C_{gd,ov} = C_{ov}$ =0.2 fF/µm	$k_{P,p}$= 110 µA/V^2 n= 1.3 V_{T0}= 0.4 V $U_{a,P}$= 10 V/µm C_{ox}= 13 fF/µm^2 C_{ov} =0.2 fF/µm	**V_{DD} = 1.2V** **$V_{GND} = V_{SS}$ =0V**

Given the following OTA and its bias circuit:



OTA with PMOS differential pair and its Bias circuits

1. Explain the role of the circuits a, b, c

- Explain the operation of (a).
- Explain the operation of (b) and size all its transistors and R_s to meet the following specifications: $\mathbf{I_{BIAS}}$ = 10 μA, I_F of M2, M3, M4 is 10 and k = 4.
- If all nMOS transistors of (a) and (b) have the same size, propose a value for R*.

2. Given the following specifications, size all the transistors of the OTA (b)

The circuit will be designed to meet the following specifications, which will be verified by simulation.

Parameter	Unit	
	Specification	
Open-loop Gain: $\mathbf{A_o}$	≈ 35 dB (56)	dB
GBW: $\mathbf{f_{GBW}}$	25	MHz
Slew rate: **SR**	20	V/μs
Load Capacitance: $\mathbf{C_L}$	1	pF
$\mathbf{I_{F,5}}$	10	

Sizing: The OTA will now be sized. Calculate the following parameters in the proposed order.

	Parameter	Expression	Value	Unit	Guideline
Bias	I_0			µA	
	$\frac{W_5}{L_5}$			µm	$L_5 = 0.5\mu m$
Differential pair amd its load	g_{m2}			µS	
	$\frac{g_{m2}}{I_{d2}}$			V^{-1}	
	$I_{F1,2}$			-	$I_F = I_c$ is the inversion factor
					Strong or weak inversion
	$\frac{W_{1,2}}{L_{1,2}}$			-	
	R_{out}			kΩ	
	$L_{1,2}$			µm	R_{out}, $L_4 = L_2$
	$W_{1,2}$			µm	
	$\frac{W_4}{L_4}$			-	$I_F = 10$
	L_4			µm	$L_2 = L_4$
	W_4			µm	
	g_{m4}			µS	

4. Determine analytically

- **the common mode input range $CMIR^+$/ $CMIR^-$**
- **the output swing**
- **the poles (dominant and non dominant)**
- **the phase margin PM**
- **CMRR**

	Analytical expression	Numerical value
A [dB]		
f_{dom} [Hz]		
f_{nondom} [Hz]		
PM [°]		
$CMIR^+$ [V]		
$CMIR^-$ [V]		
V_{OUTmax} [V]		
V_{OUTmin} [V]		
ΔV_{OUT} [V]		