Ultra Low Power Circuits

Master Degree (M.Sc.) in Electrical and Computer Engineering

5th year, 1st Quarter 2022-2023

#1 Circuits Report (1 week -October 7, with report)

Goals: Get the feeling for Currents and Voltages values in sub-threshold and in strong inversion.

To Do:

1) NMOS transistor simulation: W=Group_number*1um/L=0.35um
    a. VDS=1.2V, 0V<VGS<1.2V
        Plot ID vs VGS, with key points and comments
    b. VGS1=0.5V; VGS2=0.4V; VGS3=0.3V; 0<VDS<0.5V
        Plot ID vs VDS for 3 VGS curves, with key points and comments.
2) Design a CMOS Inverter with Vth=VDD/2~0.6V
    a. VDD=1.2V, 0V<VGS<1.2V
        i. Plot Vo vs Vi
        ii. Plot ID vs VGS, with comments
    b. 0V<VDD <1V, 0V<Vi<VDD
        i. Plot Vo vs Vi, with comments

Report:

1 page with Identification and plots; 1 page with relevant comments

#2/#3 Analog Report (2 weeks -October 21, with report)

Goals: Design of a Low-gm Amplifier.

To Do:

Consider V_{DD}=1V and a current source of 2uA.

1) Design a transconductance amplifier (Fig.1) with i_O/v_d<10uS. Consider schematic changes in the current mirrors with the circuit in Fig.2. Consider using the transistors in the differential pair in weak inversion.
2) Estimate the operation zone of the transistors.
3) Obtain the gain and output resistance of the amplifier.

Report:

4 pages with Identification, dimensioning, plots; and relevant comments.

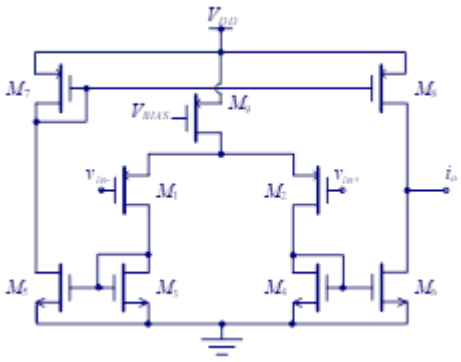


Fig. 1 Amplifier schematic

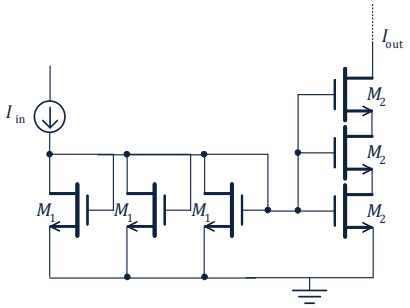
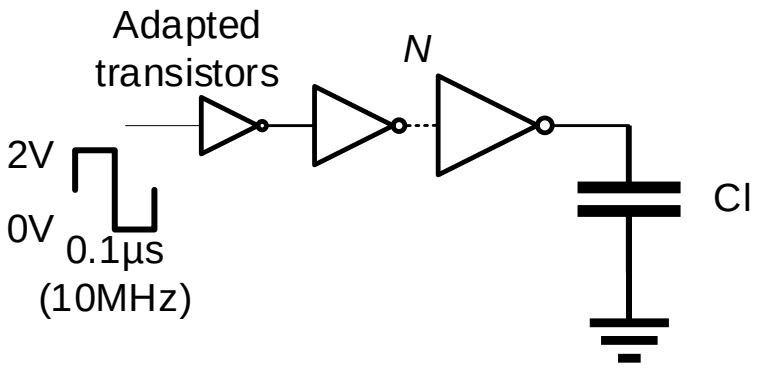


Fig.2 Current mirror scaling

#4 Digital Report (2 weeks -November 4, with report)

Goals: Design of a digital output driver.

To Do: Design an output driver employing CMOS inverters.



Constraints:

Output capacitance C_l=10pF

Supply voltage 2V

Frequency 10MHz

Design space:

Number of stages *N*

Inverter structure First inverter: NMOS minimum dimensions; PMOS adapted.

All other inverters free.

Transistor dimensioning

Goals:

Minimize power consumption

Minimize Area

Report (5 pages):

2 pages with Identification, figures and plots; 3 pages with relevant comments.