

Question 1 (10 min, 1 pto).

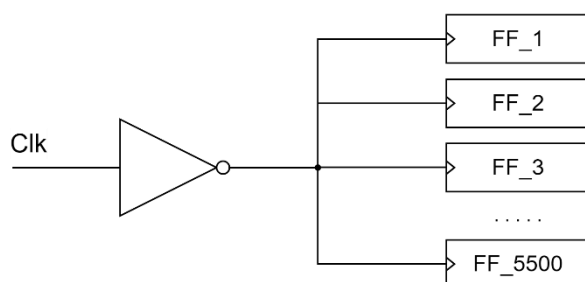
Explain the different types of oxide used in the manufacturing process of CMOS integrated circuits and their functions.

Exercise 1 (40 min, 2.5p)

We want to design the clock tree for a circuit with 5500 flip-flops.

If the solution is not unique for any of the questions, try to optimize delay and area.

a) Obtain the delay and area for a single stage clock tree (the one in the figure) in terms of the minimum size (W) inverter delay (t_{pi}) and area (A_0).



b) Obtain the delay and area for a clock tree with a maximum fanout of 20.

c) Obtain the delay and area for a 5-stage (splits) clock tree.

d) Obtain the delay and area if we use a chain of increasing size inverters, delay optimized.

Exercise 2 (60 min, 4 pto).

The diagram in the figure shows the physical scheme of a digital circuit.

a) Obtain the transistors scheme from the figure layout.

b) Obtain the status of the P and N transistors (On and Off) for the transistors generating Aux1 and Aux2 signals.

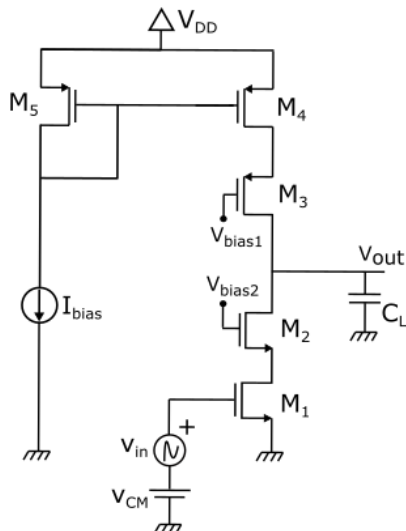
c) Specify the simplified logic function of *OutputS* in terms of inputs (A, B, C and Sel).

d) Draw the logic gate and block diagram for c) part.

e) Draw the the cross-section view of the XY cut.

Exercise 3 (40 min, 2.5p)

The amplifier below has been designed with a CMOS node of 50nm:



with the following features:

	NMOS	PMOS
$\mu^*C_{ox} (\mu A/V^2)$	60	40
$\lambda (V^{-1})$	0.6	0.6
$V_{th} (V)$	0.28	-0.28

$V_{DD} = 1.2 V$, $L = 100 nm$ for all the transistors. All the transistors work in saturation,

$$(W/L) M_1 = (W/L) M_2 = 30$$

$$(W/L) M_3 = (W/L) M_4 = 60$$

$$C_L = 500 fF, 1 fF = 10^{-15} F$$

V_{CM} is a DC voltage source and V_{in} is an AC voltage source.

Answer the following questions:

- Assuming that M_4 and M_5 are identical, compute I_{bias} to have a GBW of 100 MHz.
- Compute the DC gain V_{out}/V_{in} in dB with the I_{bias} computed previously.
- What is the bandwidth?
- What is the mean power consumption?
- What is the purpose of the voltage source V_{CM} ?

Note: All the questions must be justified. Answers with no justification will score 0.

