

## Project #5: D Flip-Flop

**Due: Tuesday April 16**

### Project Introduction

For this project you will be using the Cadence Design tools to design, layout and characterize the D-Flip-Flop as designed in class (no other FF allowed!).

### Project Goals

- 1) Minimize diffusion breaks and cell width
- 2) Match the cell height to that of your cells in Project 4, given that the height of the pdiff must be able to contain 5 contacts and ndiff must be able to contain 3 contacts. (It may be necessary to increase the height of your Project 4 cells.)

### Project Rules & Requirements

- 1) Use exactly the DFF design shown in class.
- 2) Input/output pins must lie on a grid (an integer multiple of the grid spacing)
- 3) Minimize the use of vertical metal2, and no horizontal metal2.
- 4) Minimize the use of horizontal poly runs
- 5) The input slew rate is 40 ps ( $0.1 \cdot V_{dd}$  to  $0.9 \cdot V_{dd}$  and vice versa).
- 6) Assume a 30fF load capacitance when simulating
- 7) The DFF cell has 4 pins: D, Clk, R (reset, active high) and one output pin (Q).
- 8) Characterize the DFF using **Siliconsmart ACE**.  
<http://www.utdallas.edu/~xiangyu.xu/siliconsmart/>

### What To Turn In (points are deducted for anything missing)

- 1) A cover page containing all the following information.
  - Name, NetID and project title
  - D Flip-Flop times:  $T_{su\_dd}$ ,  $T_{su\_opt}$ ,  $T_{hold}$ ,  $T_{clk \rightarrow Q}$ , and  $t_D$
  - Clearly state your width and height on the front.
- 2) Please include a short report describing the following
  - How you found your D Flip-Flop times
  - How you came up with your layout
- 3) D Flip-Flop layout with rulers showing the dimensions of the cell.
  - Show the uniform distance of your pin grid
  - Show height & width of entire cell
- 4) Waveforms and explanation showing how you computed  $T_{su\_dd}$ ,  $T_{su\_opt}$ ,  $T_{hold}$ ,  $T_{clk \rightarrow Q}$ , and  $t_D$ .
- 5) Spice testing setup file (Don't include any spice netlist)
- 6) A hardcopy of project report is required; no soft copies.

### Grading Breakdown

- 1) Correct functionality 30%
- 2) Cell area 25%
- 3) Number of vertical M2 lines used 25%
- 4) Report 20%