Homework 1: Standard Cell Libraries

Marks 57

Submission due: Sep 11, 11:59pm
To be submitted individually

Pls fill up the tables here, with screenshots or explanation on how you obtained the values for the table. Just writing values in the table will not fetch marks. We will also run a viva by selecting random set of students who should be able to explain their report.

All PDKs are shared here:

https://iiitbac-my.sharepoint.com/:f:/g/personal/nanditha_rao_iiitb_ac_in/EizEGKw2spVDp_pYhqqC-I8BdFydMW8EZkSDBfdOrXisnA?e=tnrw7a

For the exercises below, you will use the following standard cell libraries:

1. Cadence 45nm PDK
   Look for the lib and lef files in this PDK

2. Nangate_15nm_OCL
   You will find the dotlib under:
   NanGate_15nm_OCL_v0.1_2014_06_Apache.A/front_end/timing_power_noise/NLDM
   You will find the LEF under:
   NanGate_15nm_OCL_v0.1_2014_06_Apache.A/back_end/lef

3. Skywater
   You will find the dotlib for the high-speed (HS) library under:
   skywater/sky130_fd_sc_hs/Liberty
   You will find the dotlib for the medium-speed (MS) library under:
   skywater/sky130_fd_sc_ms/Liberty

4. NanGate OCL

Create Links to the Library Files
First, from your home directory, set up *links* to all the files or directories listed above. This saves you the trouble of having to specify the whole path each time to access those files or directories. You can even use simpler names to reduce typing. A link is essentially a shortcut. It is a type of file in unix that points to another file or a folder on your computer.

To create a link, you use the unix “ln -s” command:

```
unix> ln -s <path to the file/folder to be linked> <name of link to be created>
```

For example:

unix> link -s /home/anandb/ultralite/tech/NangateOpenCellLibrary_PDKv1_3_v2010_12/Front_End/Liberty nangate_lib

When you run “ls -l” at your unix prompt, links will be listed with an “l” in the first field: lrwxrwxrwx

Using pipelined unix commands like grep, determine and tabulate the data requested below. When using grep, you will likely need to use the -A and -B options to get the lines you need.

(A) **Cell counts and types**
12 marks

	Cadence	NanGate_OCL	Nangate_15nm	Skywater HS
Total No. of Cells				
DFFs				
Total no. of DFFs				
No. of DFFs with reset				
No. of DFFs with set				
No. of negative edge-triggered DFFs				
NAND gates				
Count of 2-input NAND gates				
Count of 3-input NAND gates				
Count of 4-input NAND gates				
Muxes				
Count of 2-input muxes*				
Count of 3-input muxes*				
Count of 4-input muxes*				

*Note that a “2-input” mux actually has a third input, which is the “select” input. Similarly, 3-input and 4-input muxes will have two select inputs, which are in addition.

(B) **Cell Drive Strengths**
16 marks

	Cadence	NanGate_OCL	Nangate_15nm	Skywater HS
Inverter				
Total count				
Max drive strength				
Min drive strength				

Buffer				
Total count				
Max drive strength				
Min drive strength				
NAND2				
Total count				
Max drive strength				
Min drive strength				
DFFs				
Total count				
Max drive strength				
Min drive strength				

(C) **Cell pin capacitances and area**
15 marks

For any gate with more than one input, the input pin capacitance will be different for different inputs. Select any one input, but be consistent and use the same input when you report capacitance vs. drive strength in the table below.

Cell	**Input Pin**	**Cadence**	NanGate-OCL	**Nangate_15nm**	**Skywater HS**
Inverter					
Buffer					
NAND2					

(D) **Operating Conditions (P-V-T)**
6 marks

In the skywater HS and MS libraries, for what P-V-T conditions are dotlibs available? Report this in a table like the following:

dotlib file name	P	V (volts)	T (°C)

You will likely need to use a series of pipelined grep commands with and without the "-v" option.

(E) **Physical Design**
Extract data from the LEF files, including techlef, to fill out the following table:
8 marks

	Cadence	Nangate_15nm
Cell height		
No. of metal layers		
Routing pitch		
Cell height in routing tracks		