**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](https://iiitbac-my.sharepoint.com/:f:/g/personal/nanditha_rao_iiitb_ac_in/EizEGKw2spVDp_pYhqqC-I8BdFydMW8EZkSDBfdOrXisnA?e=rykJH5)

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

1. 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

1. 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: **l**rwxrwxrwx

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.

1. **Cell counts and types**

**12 marks**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Cadence | NanGate\_OCL | Nangate\_15nm | Skywater HS |
| Total No. of Cells | 960 | 1195 | 2336 | 7896 |
| **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.

1. **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 |  |  |  |  |

1. **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 |  |  |  |  |  |
|  |  |  |  |  |  |

1. **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 (oC) |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

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 |  |  |