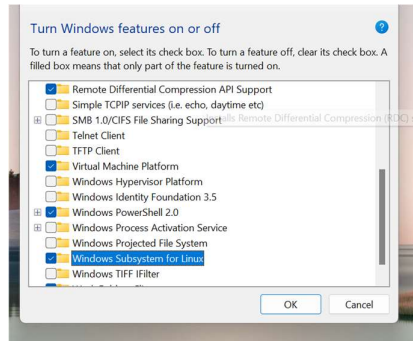### *Skywater 130 PDK, Ngspice and Magic Installation*

PART1: INSTALLATION OF WSL on Windows machine

1. On Windows machine the installation must be done via WSL. For Linux users, WSL can skipped and you can proceed with Part2.
2. For windows 11 machine, from the search bar→ turn windows feature on and off. Enable Virtual machine platform and Windows Subsystem for Linux. Restart your machine.

For Windows 10 machine, this is not required.

3. Now, Open terminal in administrative mode.
4. Note: On Windows, make sure your Username doesn't have any space. If so then change.

```
C:\Users\Iyer>echo %USERNAME%
Iyer
```

5.

6. Now we will install Linux distribution by typing the below command
   wsl --install -d Ubuntu-18.04
   It will ask for username and password. Create one and make sure to note it and save for future.

You can type "exit" to come out of the linux environment back to your Powershell.
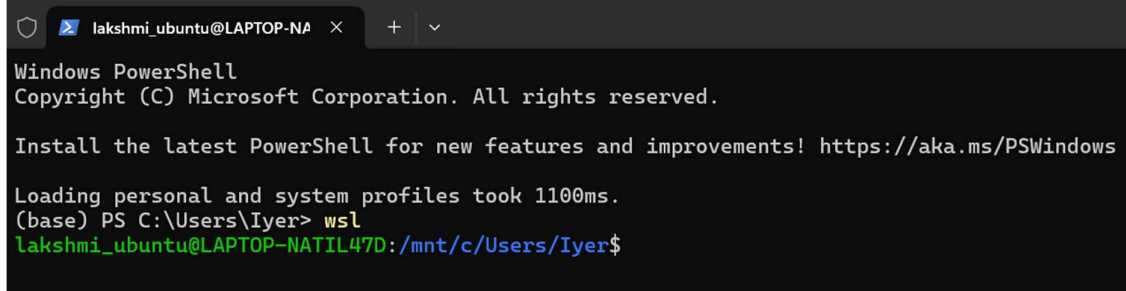**Restart your machine**

7. Now, again open terminal (run as administrator) and type the below commands
   ➢ wsl --update
   ➢ wsl --shutdown
   ➢ wsl

8. Now type the command

   ➢ `sudo apt-get update`

   ➢ `sudo apt upgrade`

   ➢ `sudo apt install build-essential`

9. Now below you can see that I have browed to my User location.

```
 🛡  ▧ lakshmi_ubuntu@LAPTOP-NA  ×    +  ∨

Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Install the latest PowerShell for new features and improvements! https://aka.ms/PSWindows

Loading personal and system profiles took 1100ms.
(base) PS C:\Users\Iyer> wsl
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer$
```
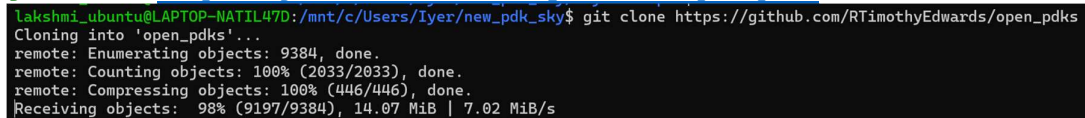
Now Let's begin installation of PDK and Tools.

PART2: INSTALLATION OF SKYWATER 130 PDK, Ngspice and Magic

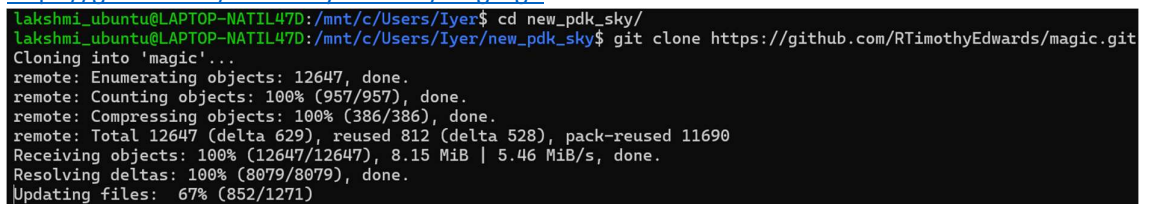1. I have created a folder "new_pdk_sky" as shown below. Browse to Open_PDK website , go to Download and
   git clone https://github.com/RTimothyEdwards/open_pdks
```
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer/new_pdk_sky$ git clone https://github.com/RTimothyEdwards/open_pdks
Cloning into 'open_pdks'...
remote: Enumerating objects: 9384, done.
remote: Counting objects: 100% (2033/2033), done.
remote: Compressing objects: 100% (446/446), done.
Receiving objects:  98% (9197/9384), 14.07 MiB | 7.02 MiB/s
```
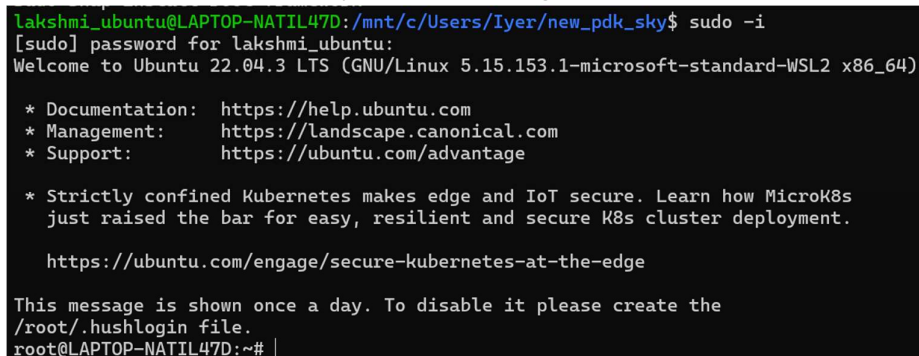
2. Now we need to install Magic. So we will clone it's git repo.
   https://github.com/RTimothyEdwards/magic.git
```
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer$ cd new_pdk_sky/
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer/new_pdk_sky$ git clone https://github.com/RTimothyEdwards/magic.git
Cloning into 'magic'...
remote: Enumerating objects: 12647, done.
remote: Counting objects: 100% (957/957), done.
remote: Compressing objects: 100% (386/386), done.
remote: Total 12647 (delta 629), reused 812 (delta 528), pack-reused 11690
Receiving objects: 100% (12647/12647), 8.15 MiB | 5.46 MiB/s, done.
Resolving deltas: 100% (8079/8079), done.
Updating files:  67% (852/1271)
```

3. Now we need to install the dependencies of magic. So, first we need to be the root user
```
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer/new_pdk_sky$ sudo -i
[sudo] password for lakshmi_ubuntu:
Welcome to Ubuntu 22.04.3 LTS (GNU/Linux 5.15.153.1-microsoft-standard-WSL2 x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage

 * Strictly confined Kubernetes makes edge and IoT secure. Learn how MicroK8s
   just raised the bar for easy, resilient and secure K8s cluster deployment.

   https://ubuntu.com/engage/secure-kubernetes-at-the-edge

This message is shown once a day. To disable it please create the
/root/.hushlogin file.
root@LAPTOP-NATIL47D:~#
```

After this type the below command

> **apt install m4 libx11-dev tcl-dev tk-dev libcairo2-dev**

4. After this we will logout from the root and install magic as shown below. Browse inside the magic directory and type the command

> ./configure

```
root@LAPTOP-NATIL47D:~# exit
logout
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer/new_pdk_sky$ ls
magic   skywater-pdk
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer/new_pdk_sky$ cd magic/
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer/new_pdk_sky/magic$ ./configure
```

5. After this type the commands

> make
> sudo make install

```
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer/new_pdk_sky/magic$ make
--- errors and warnings logged in file make.log
make[1]: Entering directory '/mnt/c/Users/Iyer/new_pdk_sky/magic'
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer/new_pdk_sky/magic$ sudo make install
--- installing executable to /usr/local/bin
```

6. Once completed, Open magic and check.

```
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer/new_pdk_sky/magic$ magic
```

7. Close the magic window. Now browse to open_pdks folder and type the below commands one by one.

./configure --enable-sky130-pdk --enable-sram-sky130
make
sudo make install
make veryclean

I am showing a sample screenshot of one of the commands below.

```
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer/new_pdk_sky$ cd open_pdks/
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer/new_pdk_sky/open_pdks$ ./configure --enable-sky130-pdk --enable-sram-sky130
checking for a Python interpreter with version >= 3.4... python3
checking for python3... /usr/bin/python3
checking for python3 version... 3.10
checking for python3 platform... linux
```

Just for your information, this will do the following:

- Automatically pull the Google/SkyWater SKY130 PDK libraries from github
- Automatically pull the 3rd-party alphanumeric layout library
- Automatically pull the 3rd-party library for the xschem schematic entry and schematic capture tool.
- Build and install all libraries to **/usr/local/share/pdk/sky130A/**.
- Build and install common scripts to **/usr/local/share/pdk/bin/**.
- Remove all staging files

8. Once done, browse to the directory new_pdk_sky and install ngspice

```
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer/new_pdk_sky$ sudo apt install ngspice
```

9. Create a folder ngspice_simulations and create a file test1.cir as shown below.

```
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer$ cd new_pdk_sky/
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer/new_pdk_sky$ ls
magic   ngspice_simulations   open_pdks
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer/new_pdk_sky$ cd ngspice_simulations/
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer/new_pdk_sky/ngspice_simulations$ ls
test1.cir
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer/new_pdk_sky/ngspice_simulations$ |
```

10. Copy the below code inside test1.cir

```
☰  test1.cir                    •    +

File   Edit   View


* SkyWater PDK
* simple inverter


.lib /usr/local/share/pdk/sky130A/libs.tech/ngspice/sky130.lib.spice tt

* the voltage sources:
Vdd vdd gnd DC 1.8
V1 in gnd pulse(0 1.8 0p 200p 100p 1n 2n)

Xnot1 in vdd gnd out not1

.subckt not1 a vdd vss z
xm01   z a     vdd    vdd sky130_fd_pr__pfet_01v8  l=0.15  w=0.99  as=0.26235  ad=0.26235  ps=2.51   pd=2.51
xm02   z a     vss    vss sky130_fd_pr__nfet_01v8  l=0.15  w=0.495 as=0.131175 ad=0.131175 ps=1.52   pd=1.52
c3  a     vss    0.384f
c2  z     vss    0.576f
.ends

* simulation command:
.tran 1ps 10ns 0 10p

.control
run
plot in out
.endc
```

11. Save the file and run as shown below

```
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer/new_pdk_sky/ngspice_simulations$ ls
test1.cir
lakshmi_ubuntu@LAPTOP-NATIL47D:/mnt/c/Users/Iyer/new_pdk_sky/ngspice_simulations$ ngspice test1.cir
******
** ngspice-36 : Circuit level simulation program
** The U. C. Berkeley CAD Group
** Copyright 1985-1994, Regents of the University of California.
** Copyright 2001-2020, The ngspice team.
** Please get your ngspice manual from http://ngspice.sourceforge.net/docs.html
** Please file your bug-reports at http://ngspice.sourceforge.net/bugrep.html
** Creation Date: Mon Mar 11 21:44:53 UTC 2024
******
|
```

You should be able to see the below result