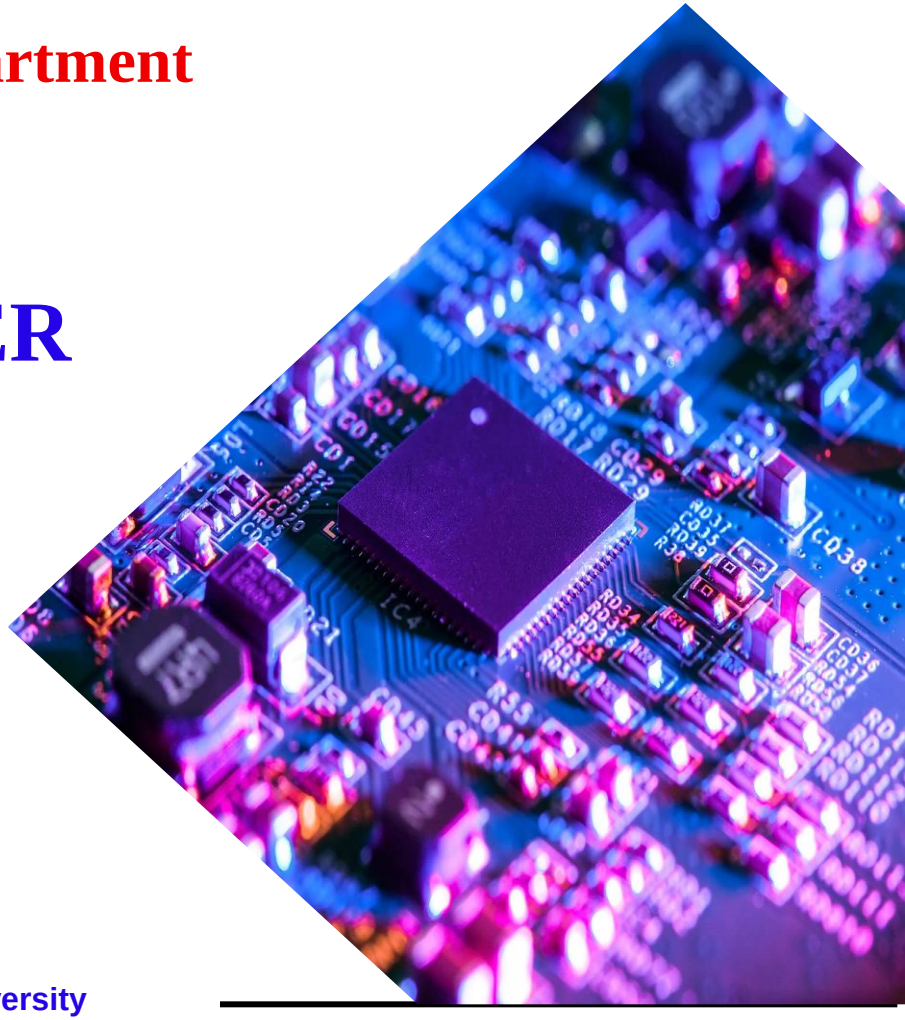
Electronics and communication department

LAB 01: CMOS INVERTER & VCO



Outline

CMOS INVERTER

COMS INVERTER STATIC Chs

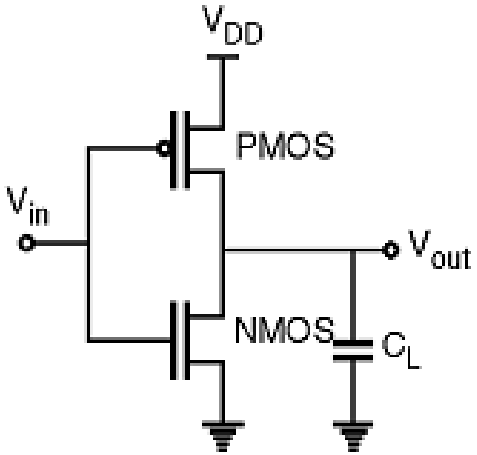
CMOS INVERTER SIMULATION

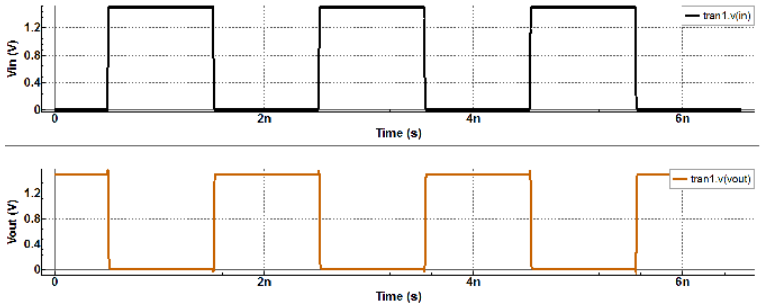
RING OSCILLATOR

VCO

REPORT

CMOS INVERTER





- Performs logical inversion (HIGH to LOW, LOW to HIGH).
- Used in microprocessors, memory chips, and logic gates.
- Power consumed mainly during switching. Why?

Static Characteristics

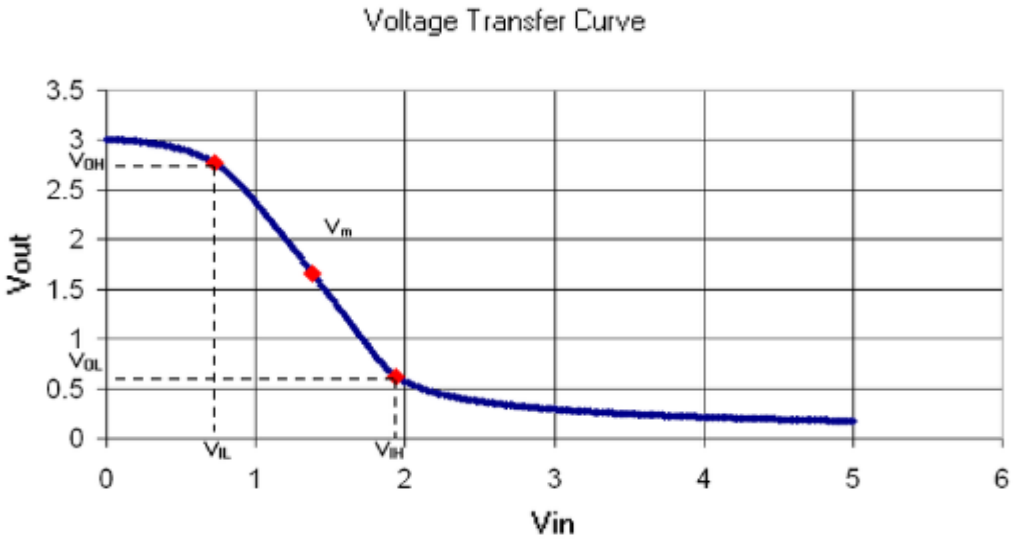


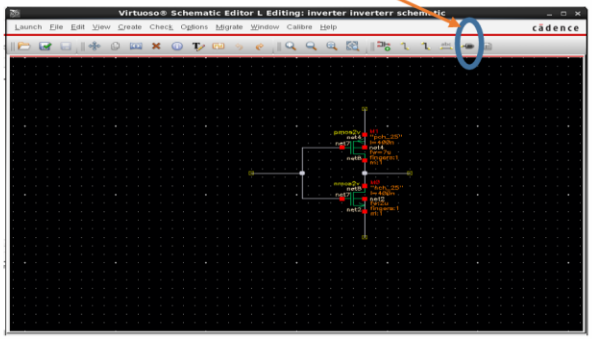
Fig.2: Voltage Transfer Curve for a typical 20 µm Inverter

- Shows the relationship between input voltage and output voltage
- Exhibits a sharp transition between HIGH and LOW states.
- **Can we utilize CMOS inverter as amplifier? How?**

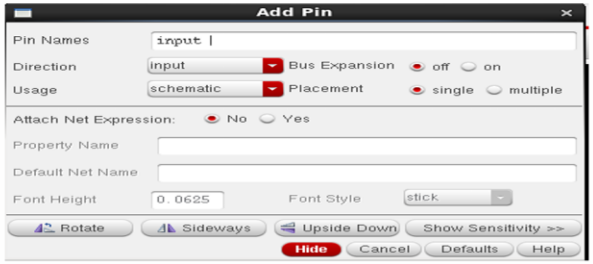
Simulation in cadence

1- Creating input/ output pins

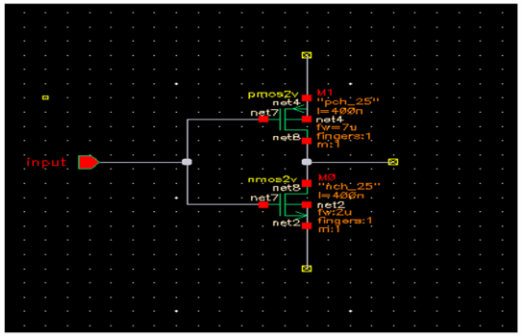
1- click on create pin icon



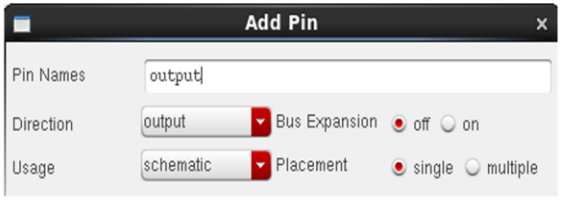
2- enter input pin name and choose direction as input



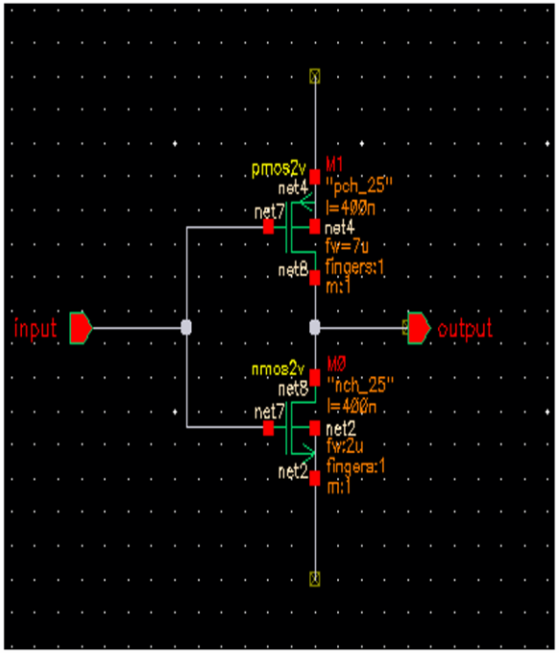
3- place input pin



4- enter output pin name and choose direction as output



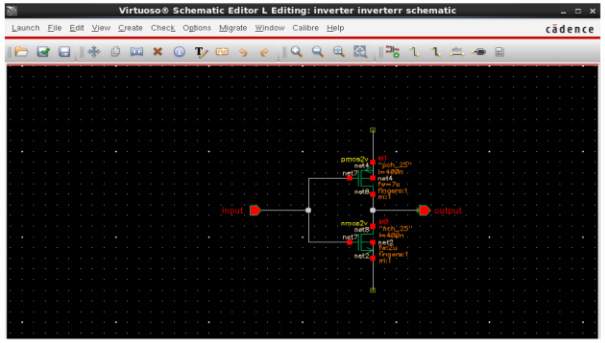
5- place output pin



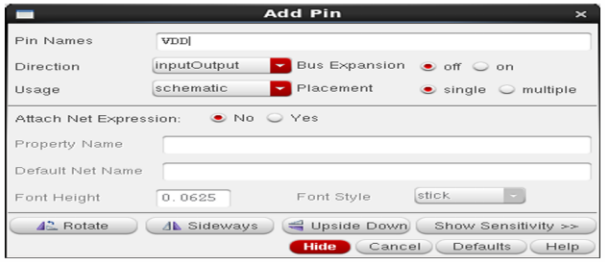
Simulation in cadence

1- Creating VDD/ GND pins

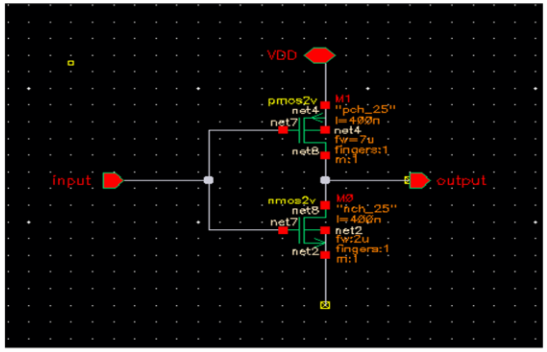
1- click on create pin icon



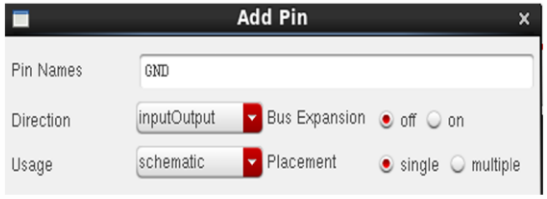
2- enter VDD pin name and choose direction as input / output



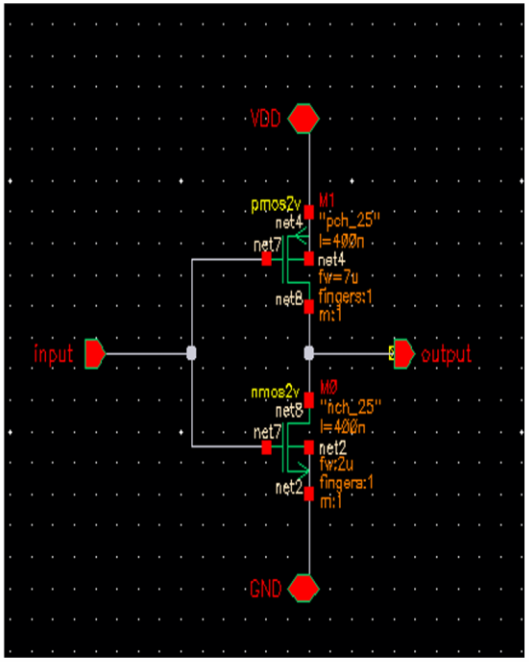
3- place VDD pin



4- create GND pin and choose direction as input/output



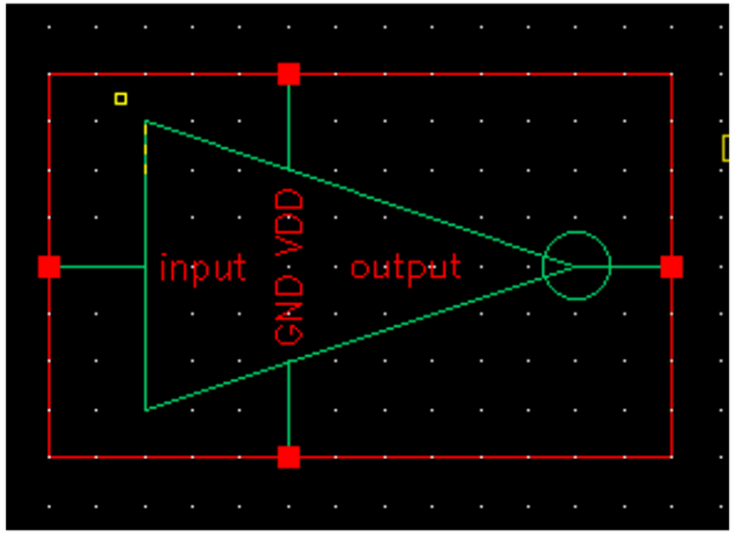
5- place GND pin



Simulation in cadence

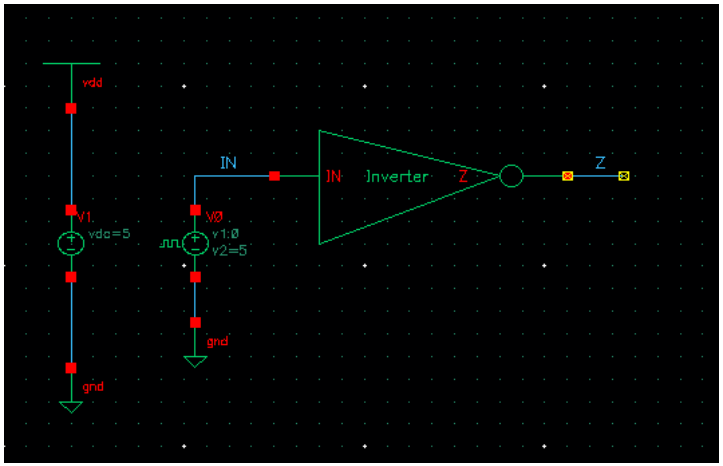
3- Create symbol

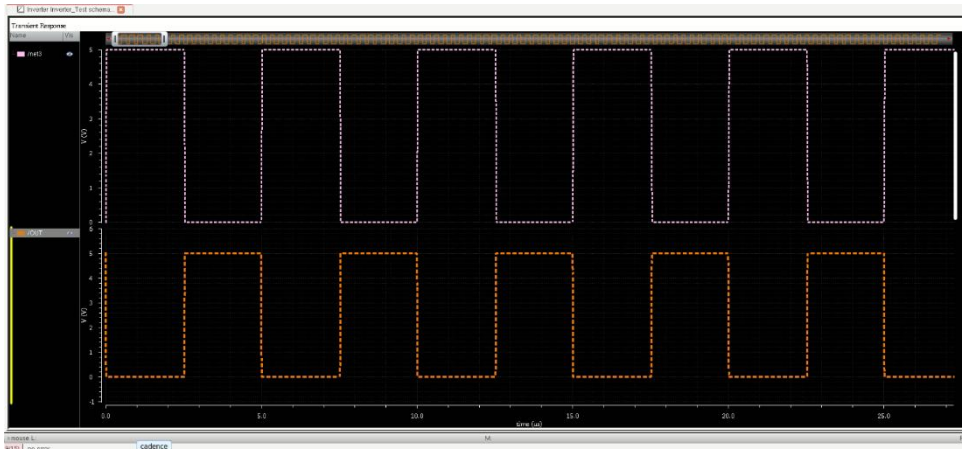
- 1- click on create---> cellview ---> from cellview
- 2- enter symbol name and click ok
- 3- check left, right, top and bottom pins and click ok
- 4- redraw the symbol as shown



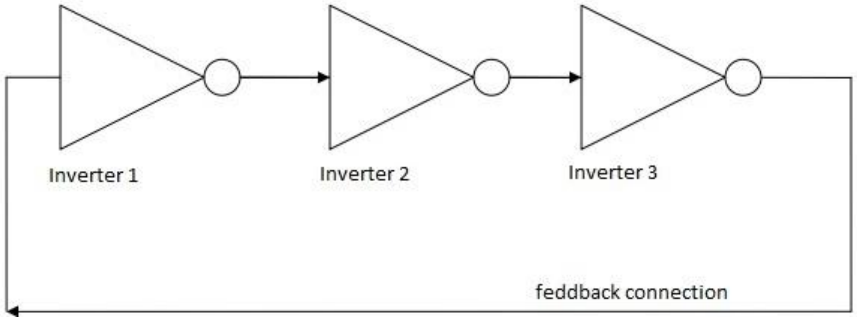
Simulation in cadence

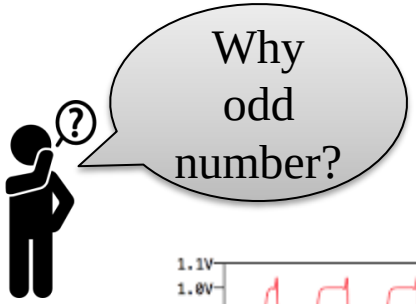
3- Run transient analysis

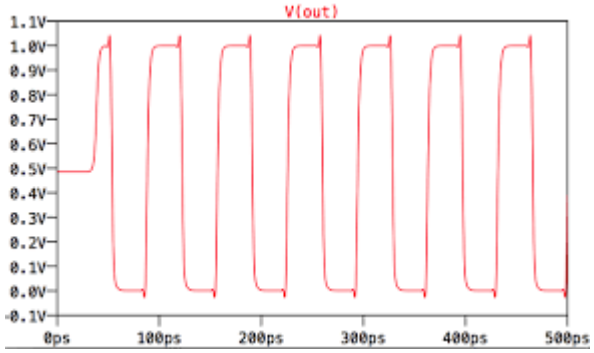




RING OSCILLATOR

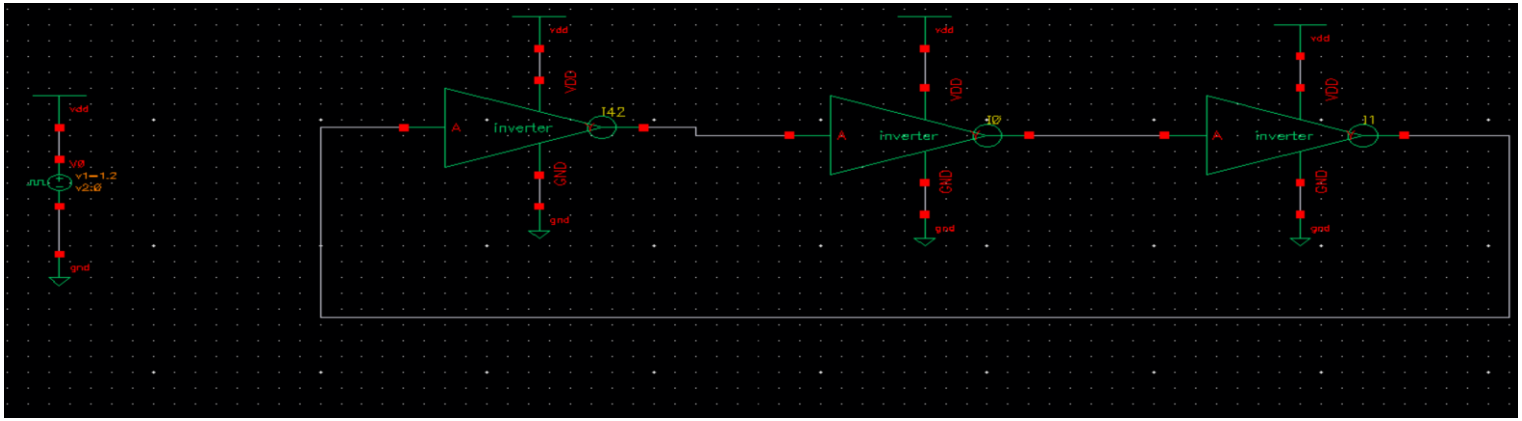


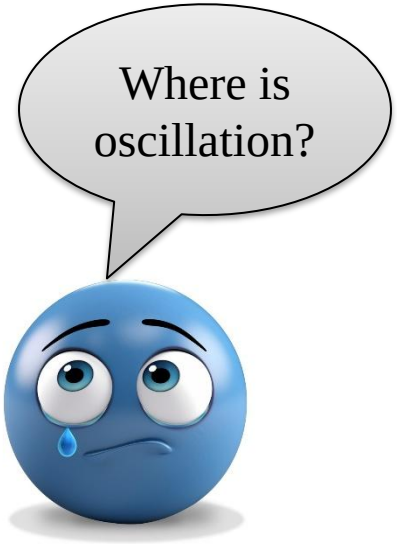


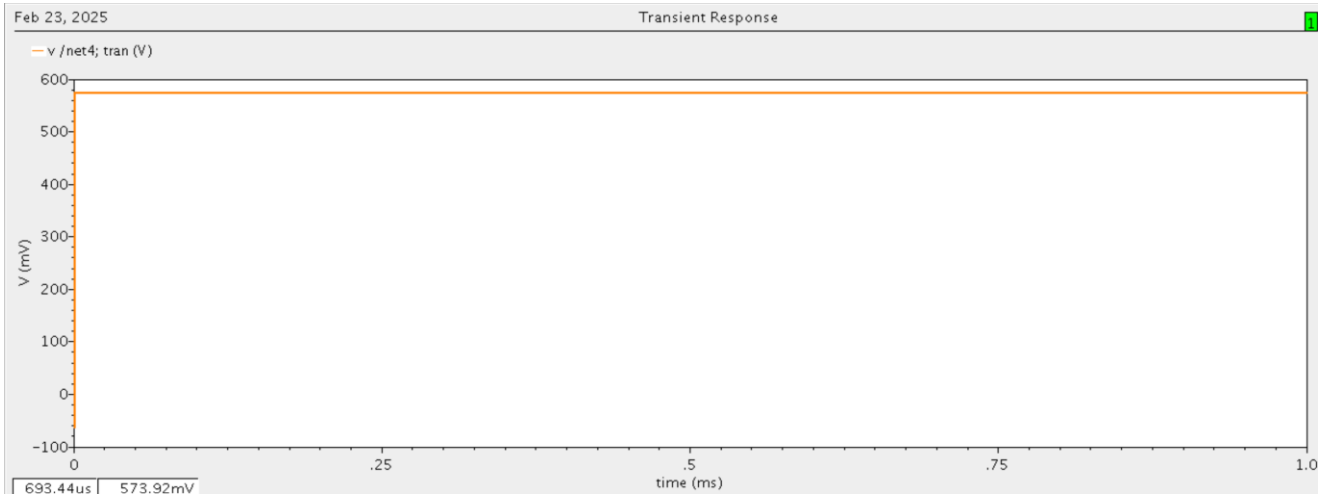


- Consists of an **odd number of CMOS inverters** connected in a closed loop.
- Frequency depends on the number of stages and propagation delay of each inverter.
- Used as on-chip clock generators in digital systems.

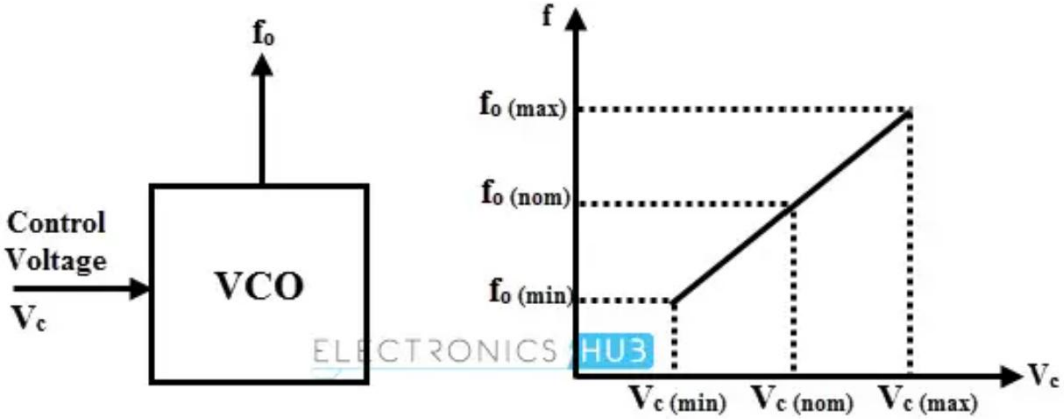
Simulation in Cadence







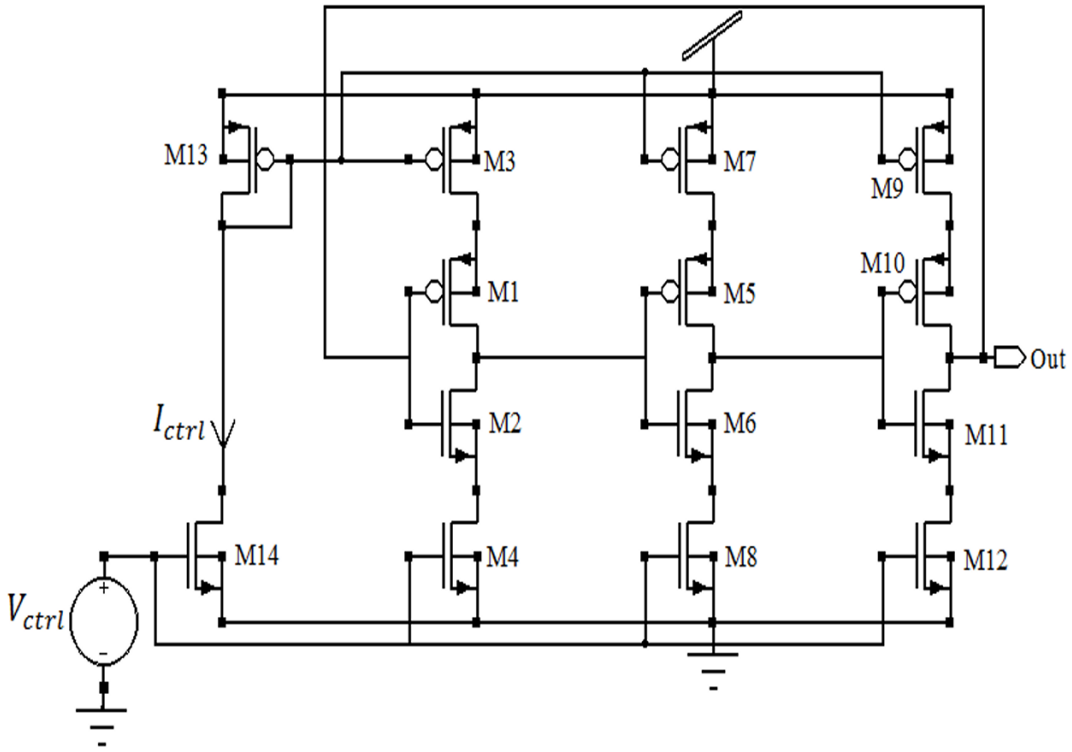
VCO



Basic VCO Operation

- Generates an output signal (sine, square, or triangular wave) with a frequency controlled by an input voltage.
- Widely used in wireless communication systems (e.g., FM radios, transceivers).
- Essential in clock generation, frequency synthesizers, and signal modulation

VCO schematic



REPORT

- In this report, you will investigate the CMOS Ring Oscillator by addressing the following questions: What is a CMOS Ring Oscillator, and what are its main applications? What are the key components, and why is it essential to have an odd number of stages? Derive the sensitivity equation for the oscillator
- simulate the CMOS Ring Oscillator in Cadence using transient analysis for a sinusoidal input voltage, and observe the input and output waveforms.

Thank You