Sharif University of Technology

Department of Computer Engineering

Low Power Digital System Design
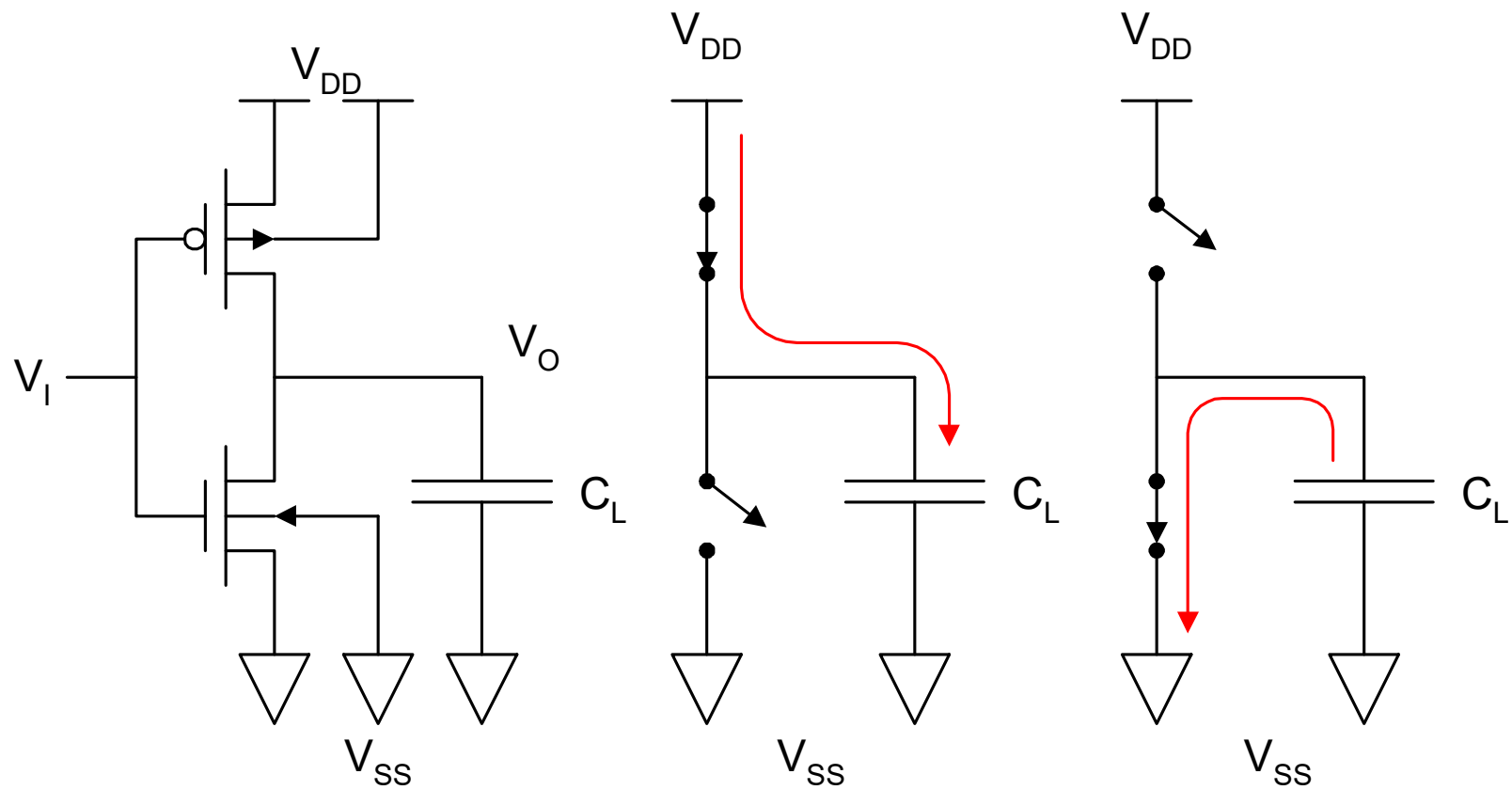
Power Components

A. Ejlali

Power Components

- Dynamic
  - caused by switching activity
    - Switching Power
    - Short circuit Power

- Static
  - Consumed even when no computations are carried out
    - Reverse Leakage Power
    - Sub-threshold Leakage Power

Switching Power

Example: CMOS Inverter

Switching Power

- Required to charge and discharge C_L.
- On rising output: $Q = C_L V_{DD}$ is stored.
- On falling output: Q is dumped to GND.
- This happens $\alpha f T$ times over an interval of T
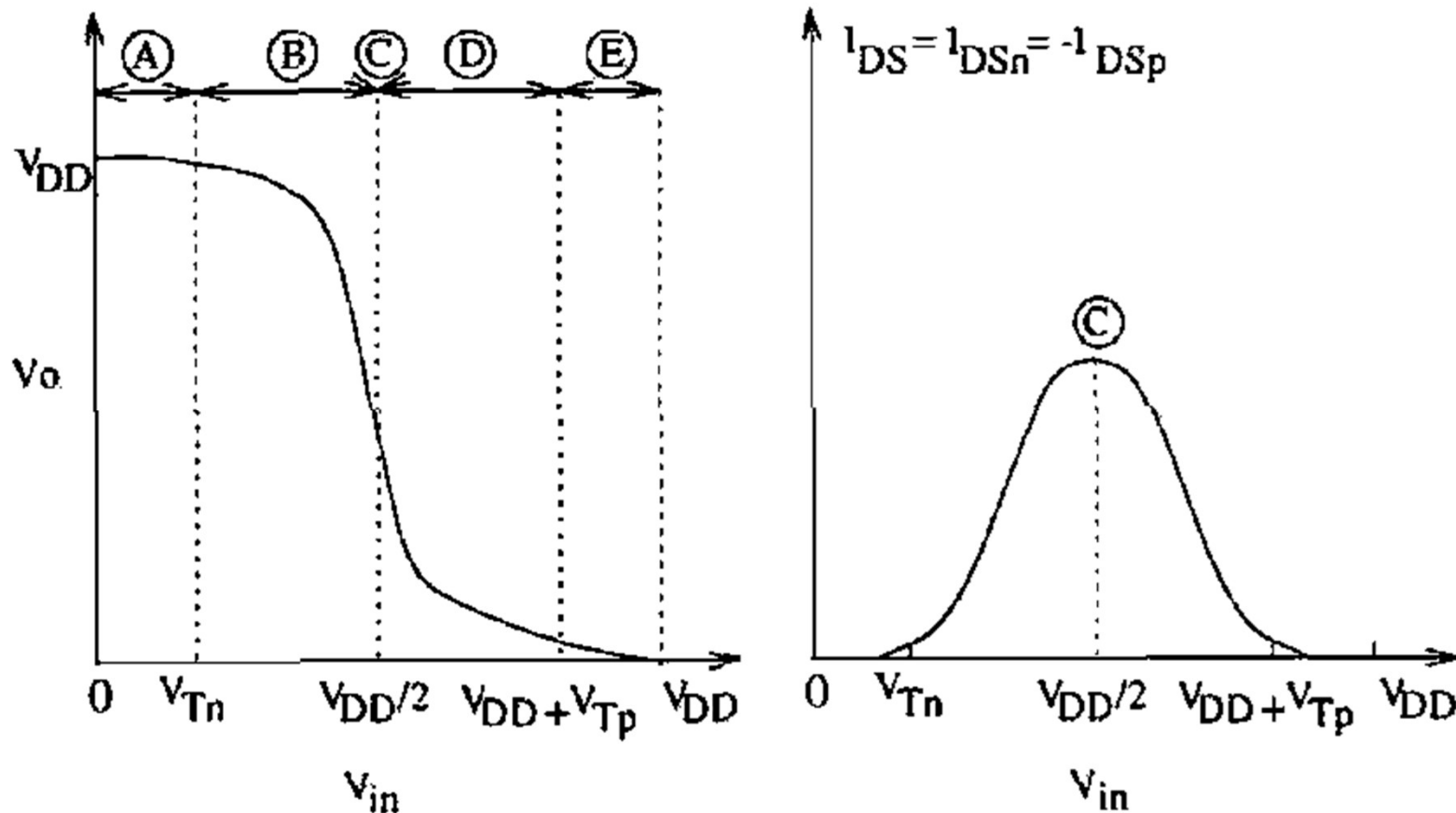
$$P_{SW} = \alpha C_L V_{DD}^2 f$$

Short Circuit Power

- When transistors switch, both nMOS and pMOS networks may be momentarily ON at the same time.

- < 10% of dynamic power if rise/fall times are comparable for input and output.

$$P_{SC} = \frac{\beta}{12}(V_{DD} - 2V_t)^3 \cdot t_{rf} \cdot f$$

CMOS Inverter:
Transfer characteristic (Review)

A: N: off **P:** linear   **B: N:** saturated **P:** linear
C: N: saturated **P:** saturated   **D: N:** linear **P:** saturated
E: N: linear **P:** off