



SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution



Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

16EC303–VLSI DESIGN

III YEAR/ V SEMESTER

UNIT 3 –SEQUENTIAL LOGIC CIRCUITS

TOPIC 3 –TIMING ISSUES



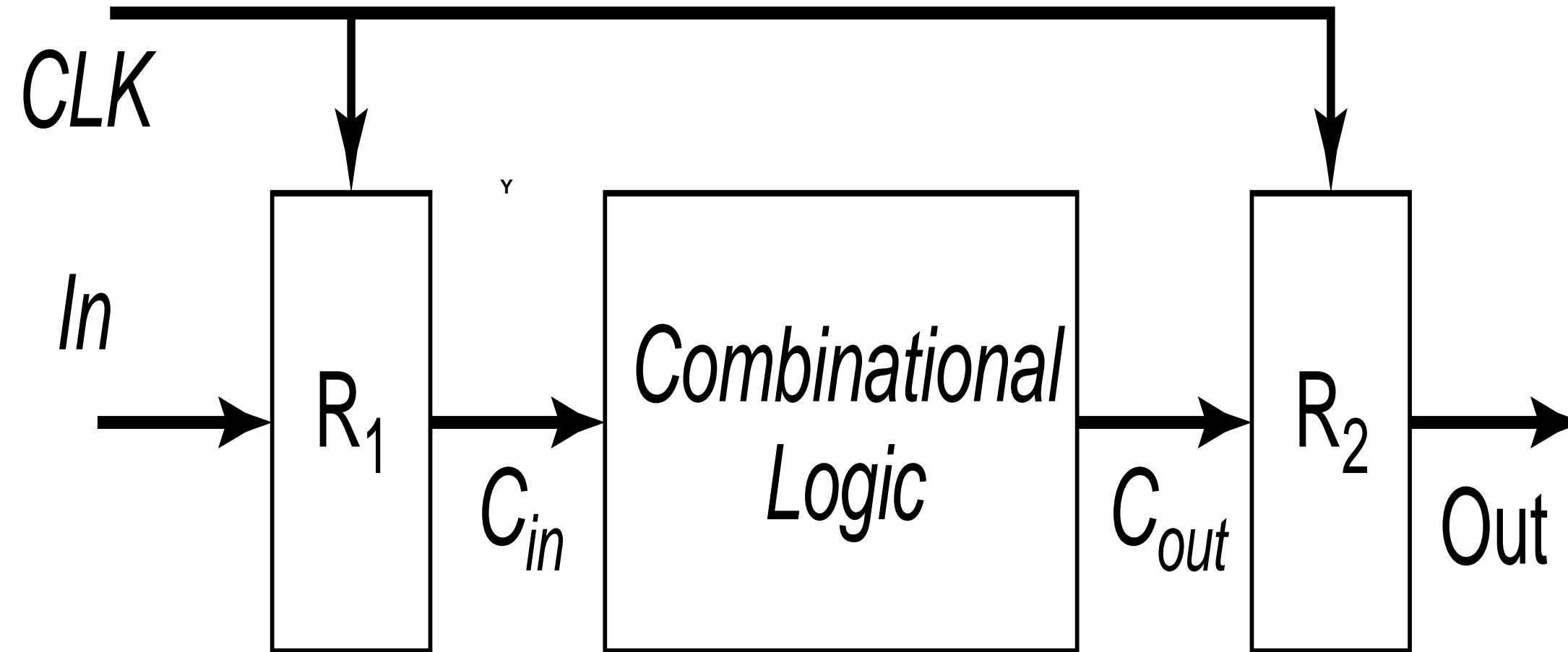
OUTLINE



- **SYNCHRONOUS TIMING**
- **LATCH PARAMETERS**
- **REGISTER PARAMETERS**
- **CLOCK UNCERTAINTIES**
- **CLOCK NONIDEALITIES**
- **CLOCK SKEW AND JITTER**
- **POSITIVE AND NEGATIVE SKEW**
- **TIMING CONSTRAINTS**
- **ACTIVITY**
- **IMPACT OF JITTER**
- **SHORTEST PATH**
- **HOW TO COUNTER CLOCK SKEW?**
- **LATCH TIMING**
- **ASSESSMENT**
- **SUMMARY & THANKYOU**

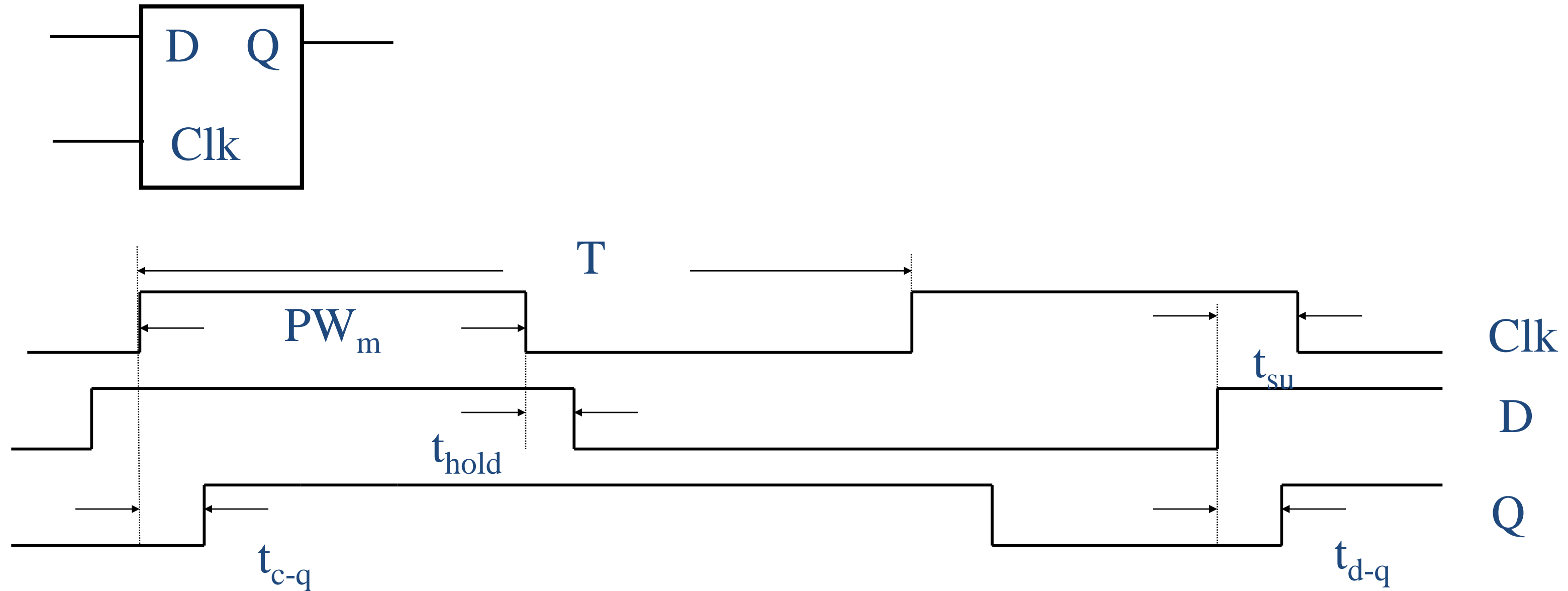


SYNCHRONOUS TIMING





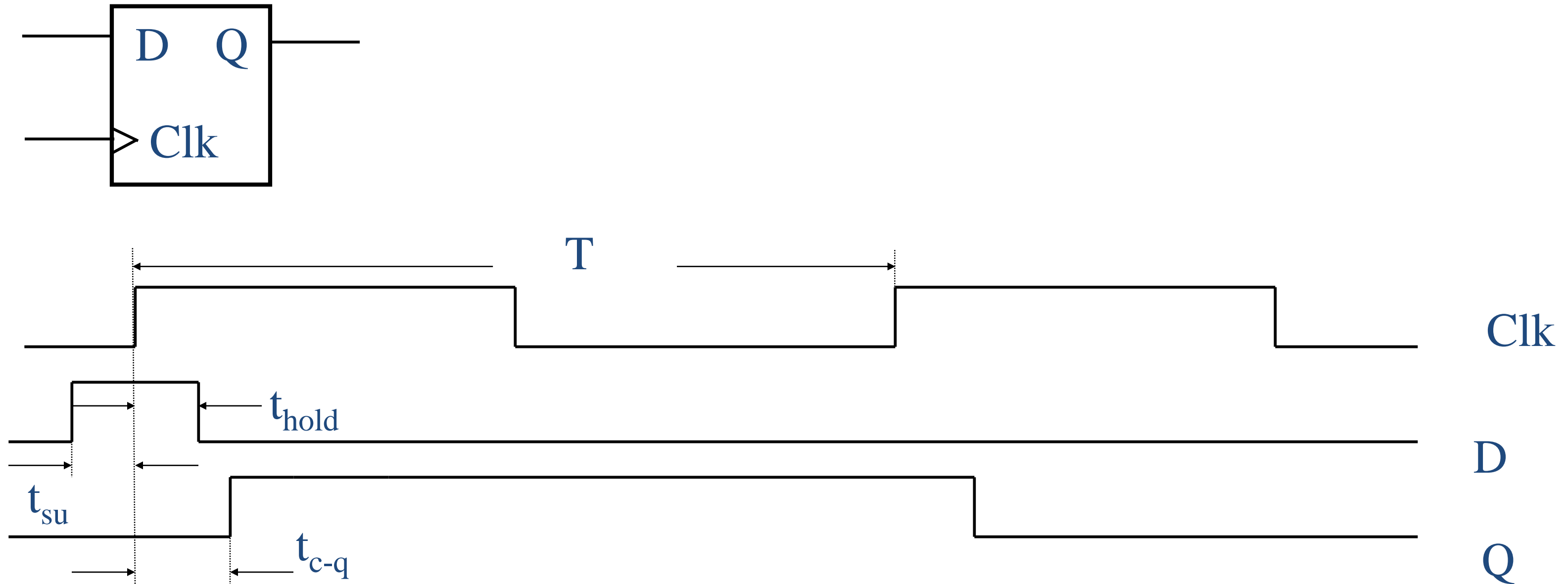
LATCH PARAMETERS



Delays can be different for rising and falling data transitions



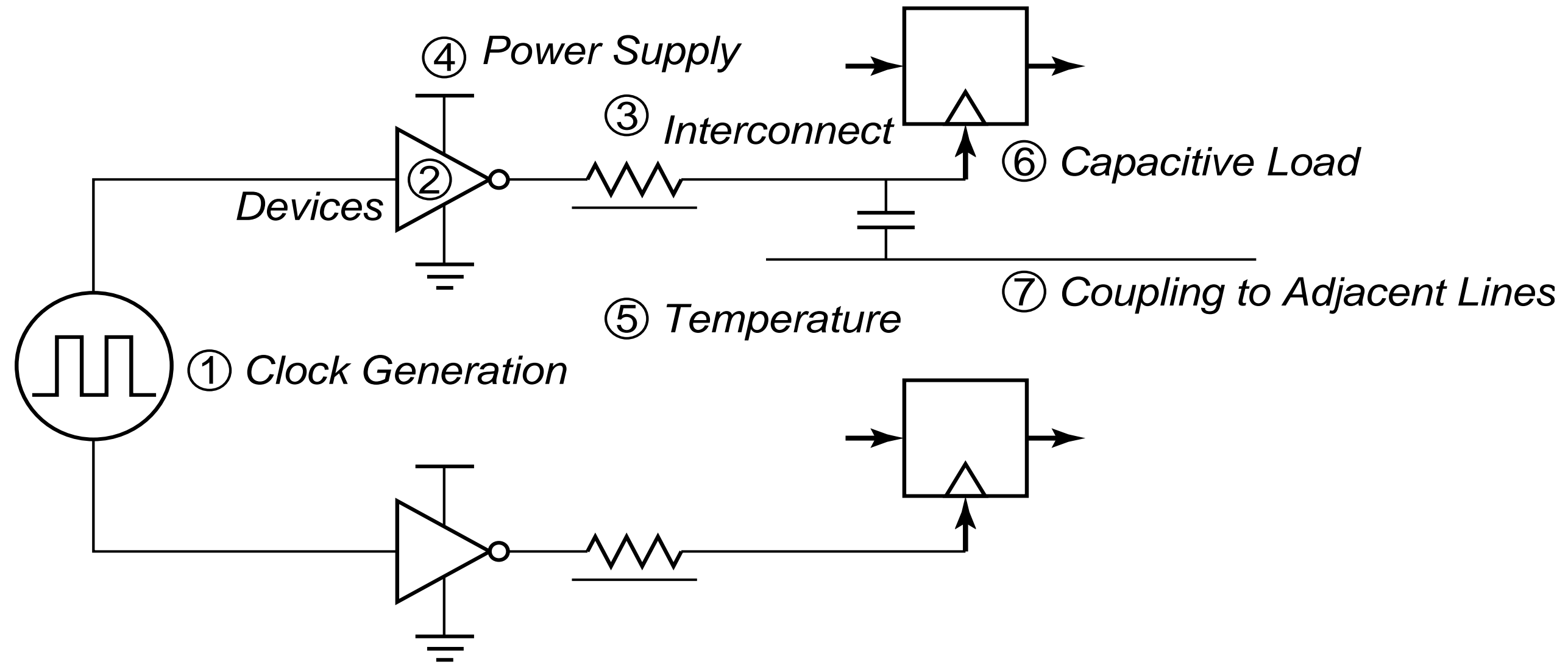
REGISTER PARAMETERS



Delays can be different for rising and falling data transitions



CLOCK UNCERTAINTIES





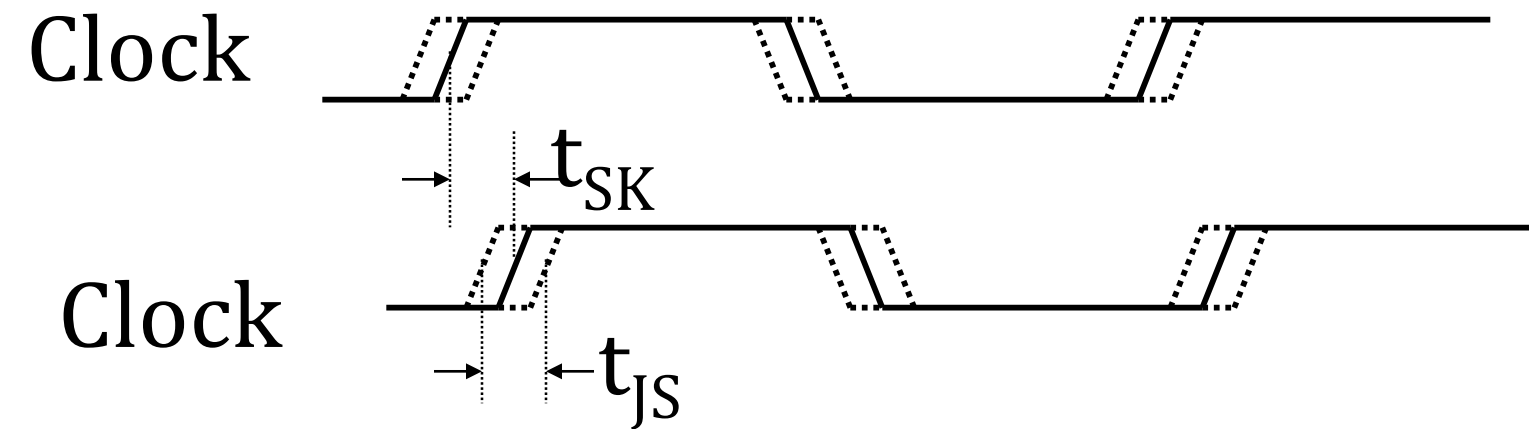
CLOCK NONIDEALITIES



- **Clock skew**
 - Spatial variation in temporally equivalent clock edges; deterministic + random, t_{SK}
- **Clock jitter**
 - Temporal variations in consecutive edges of the clock signal; modulation + random noise
 - Cycle-to-cycle (short-term) t_{JS}
 - Long term t_{JL}
- **Variation of the pulse width**
 - Important for level sensitive clocking



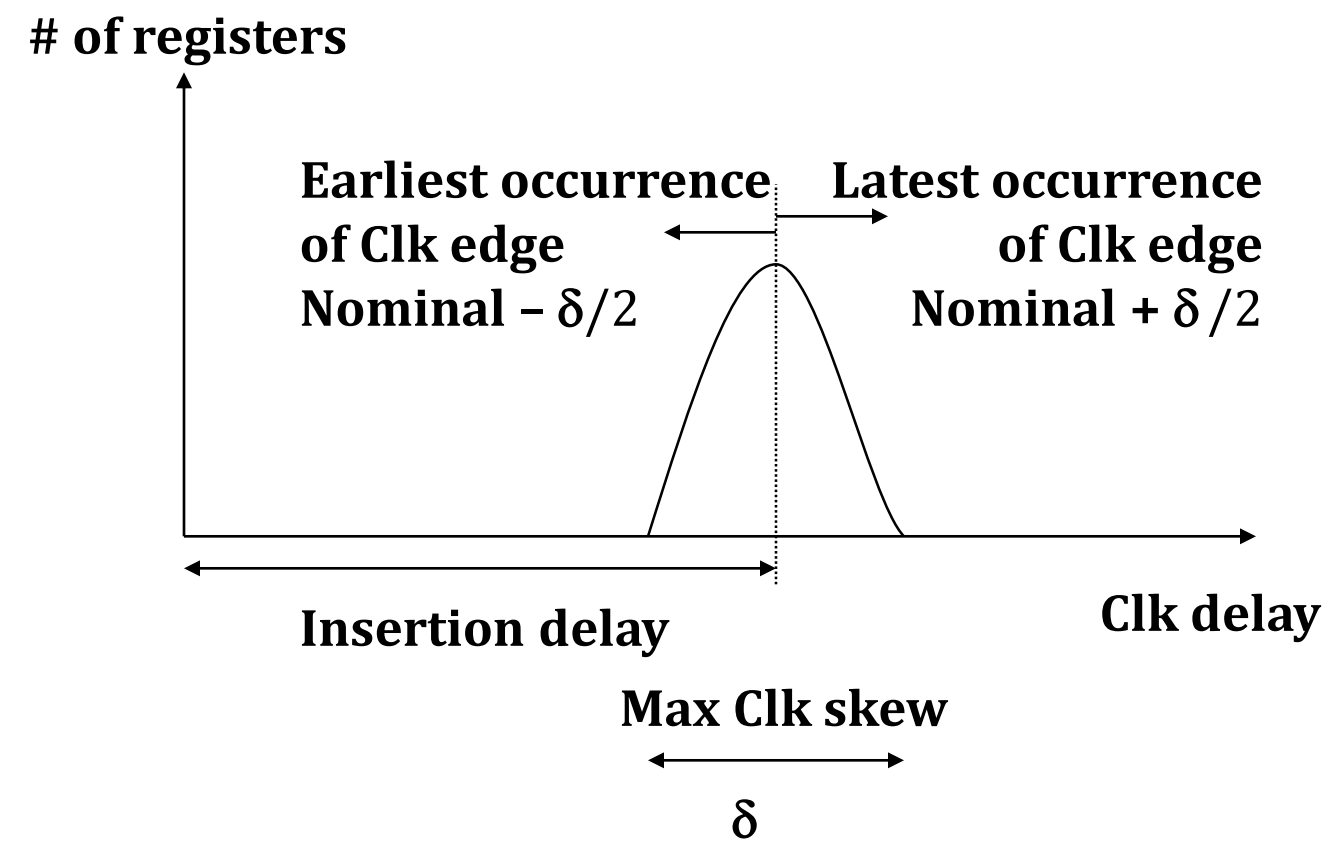
CLOCK SKEW AND JITTER



- Both skew and jitter affect the effective cycle time
- Only skew affects the race margin

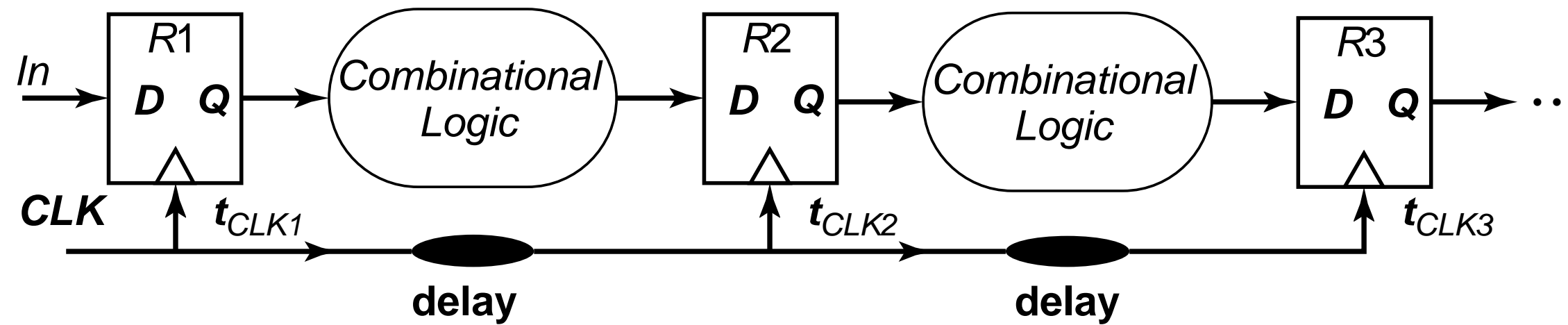


CLOCK SKEW

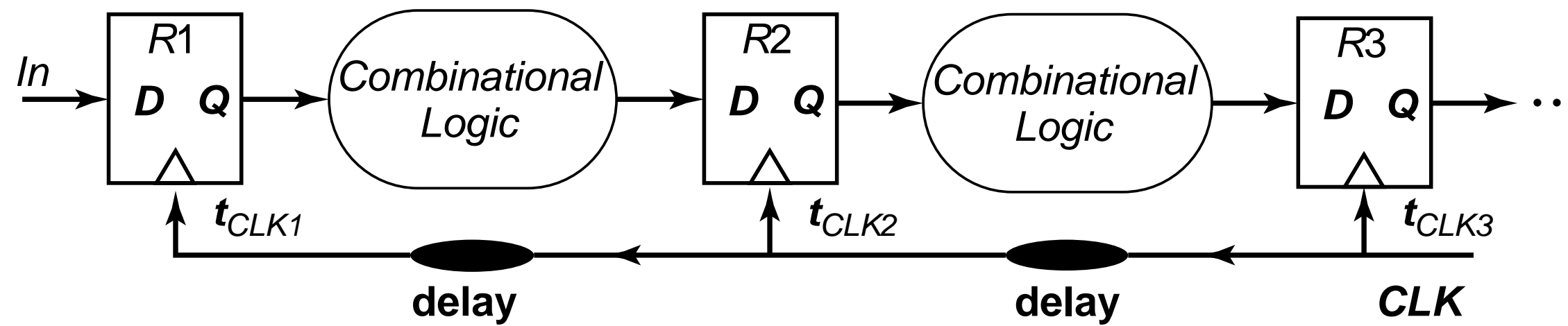




POSITIVE AND NEGATIVE SKEW



(a) Positive skew



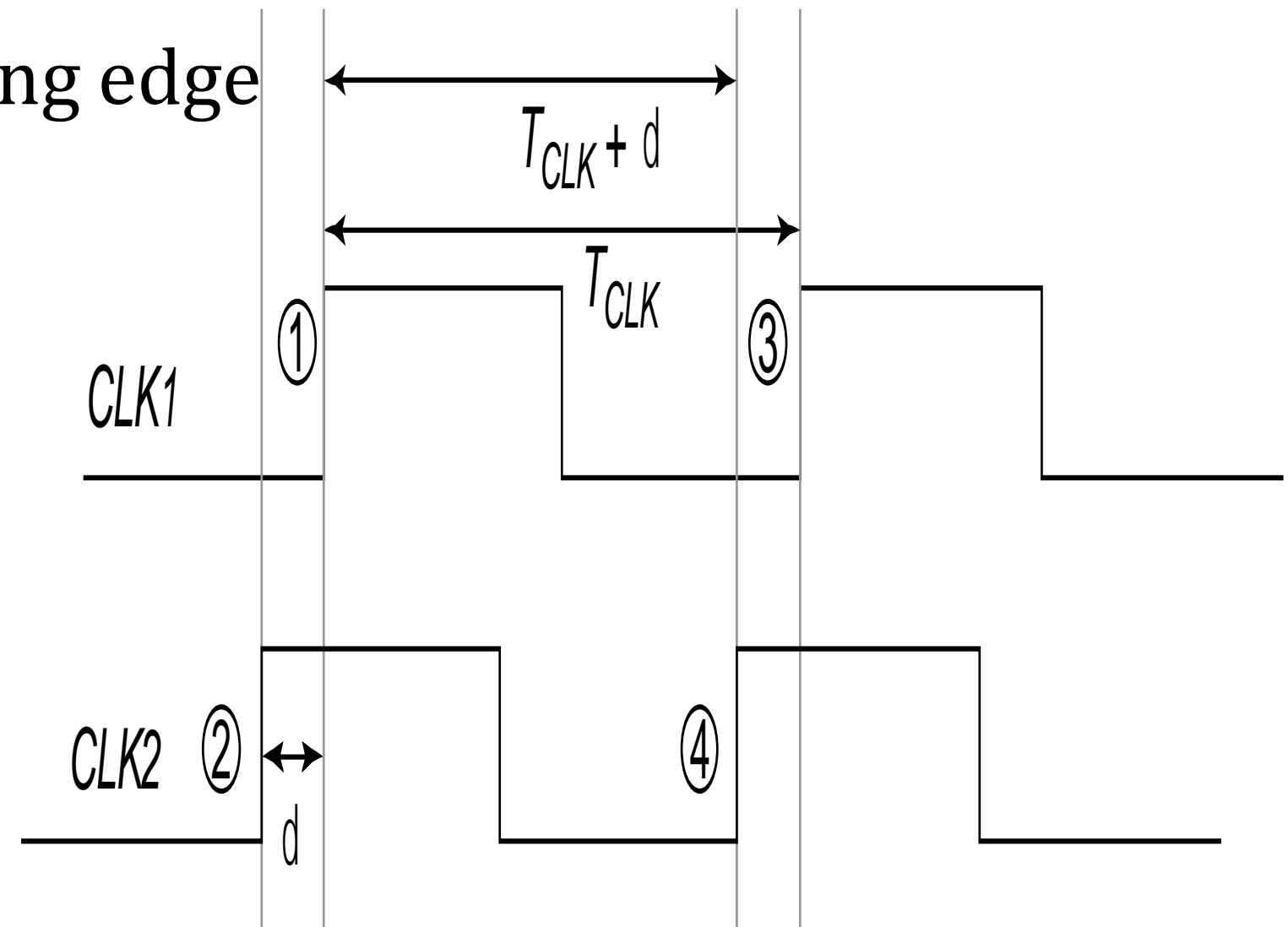
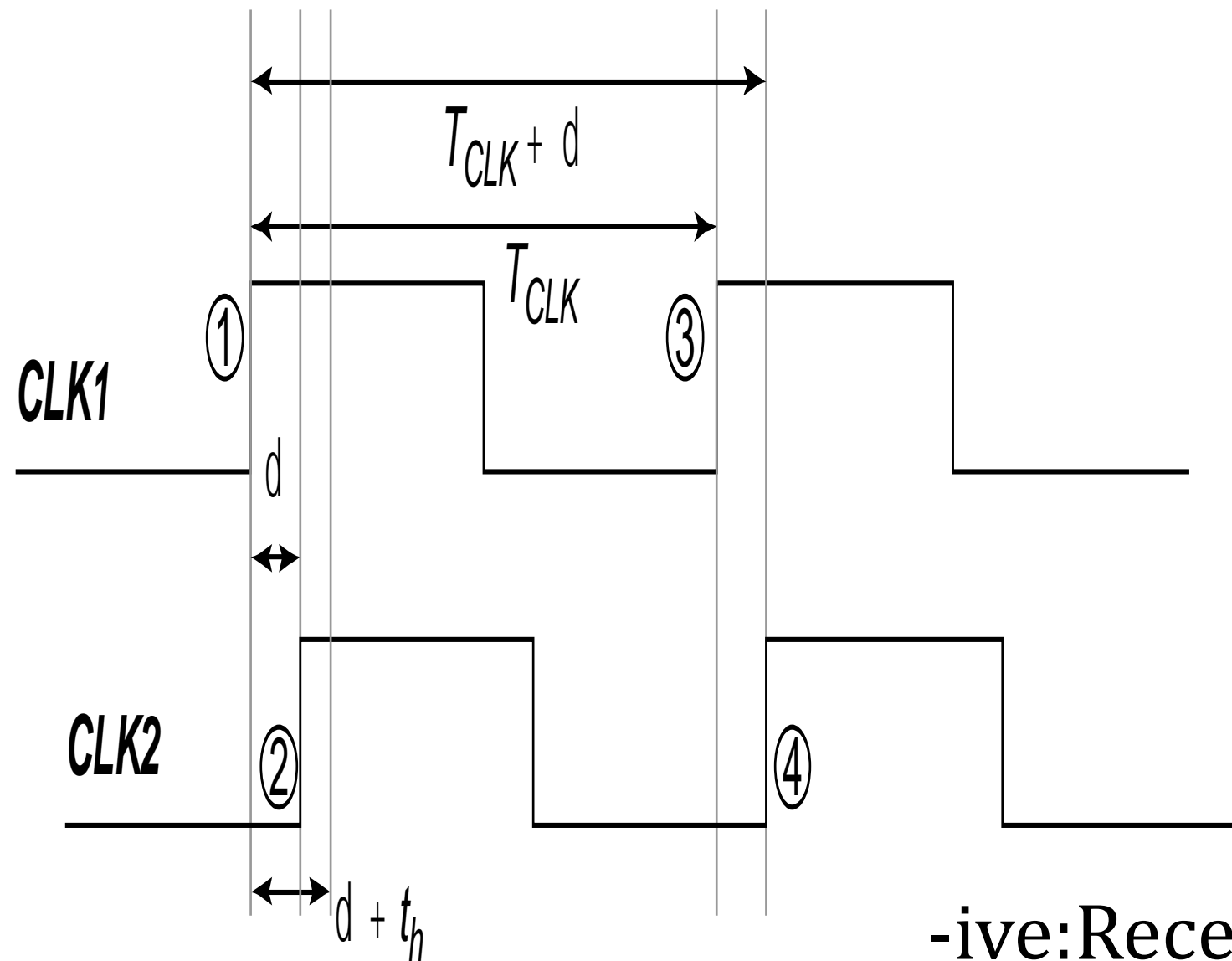
(b) Negative skew



POSITIVE SKEW & NEGATIVE SKEW



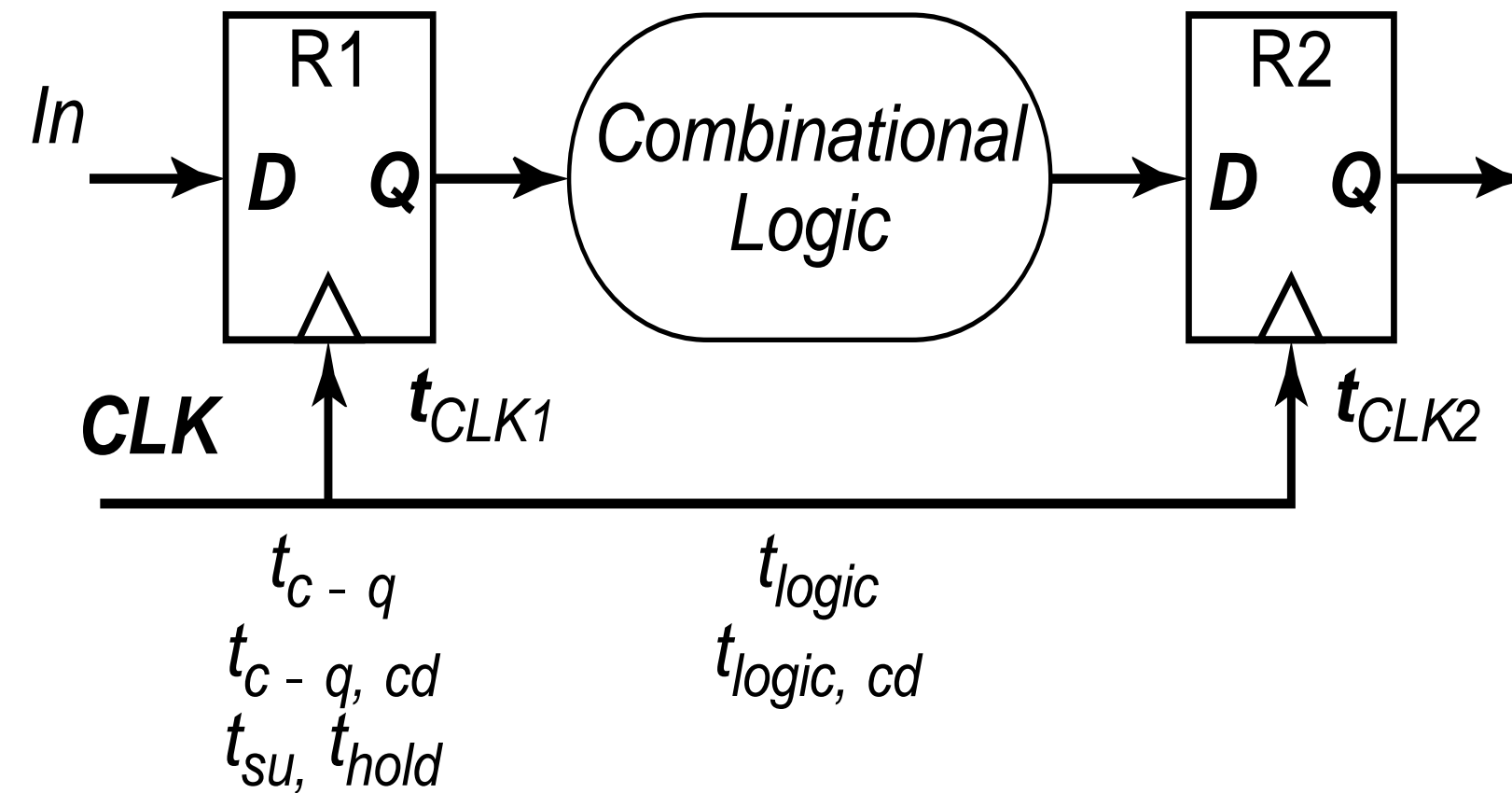
Launching edge arrives before the receiving edge



-ive:Receiving edge arrives before the launching edge



TIMING CONSTRAINTS



Minimum cycle time:

$$T - \delta = t_{c-q} + t_{su} + t_{logic}$$

Worst case is when receiving edge arrives early (positive δ)



CLASS ROOM ACTIVITY



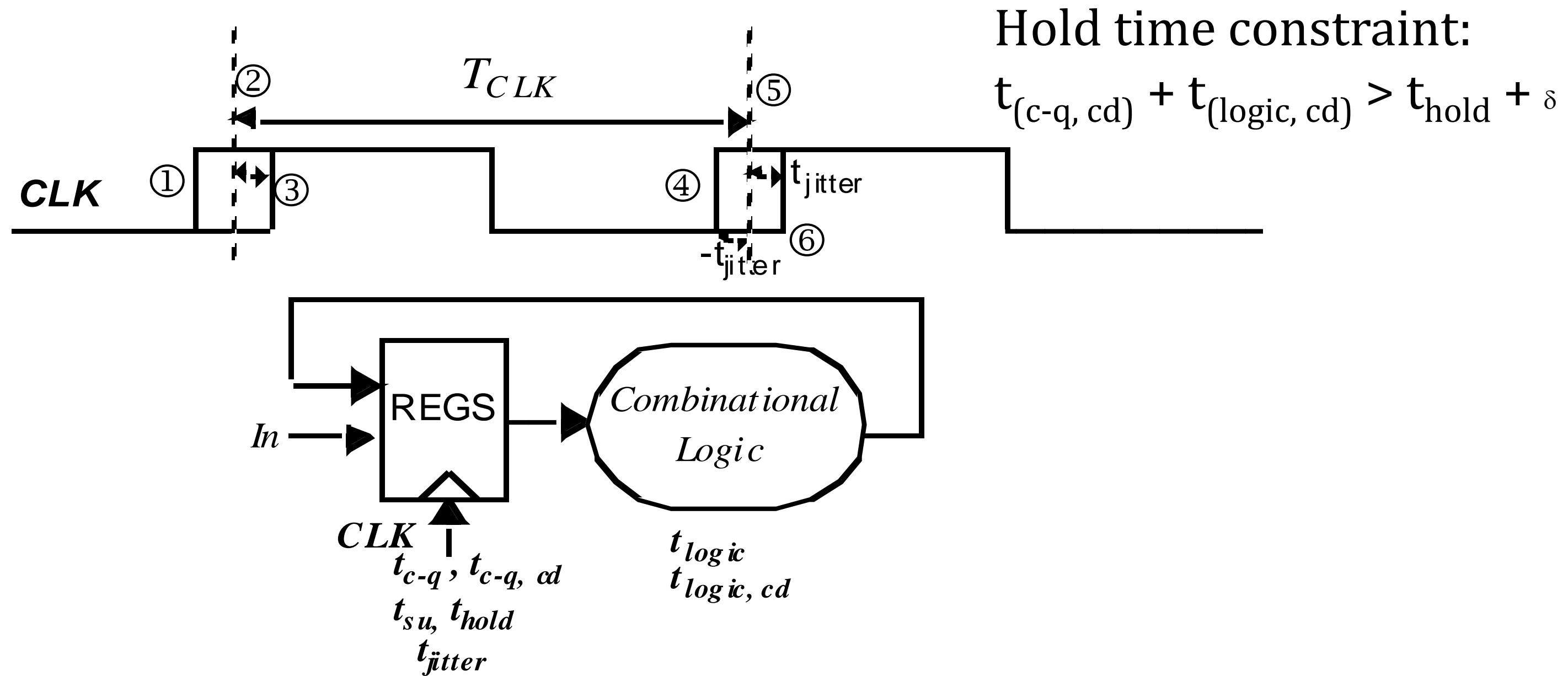
STUDY THE PYRAMID CAREFULLY.

| | | | | | | |
|-----|-----|------|-----|-----|-----|-----|
| | | | E | | | |
| | | 1110 | | D | | |
| | 446 | | 679 | | 681 | |
| 198 | | 263 | | 431 | | 265 |

WHAT ARE THE VALUES OF E AND D?



IMPACT OF JITTER

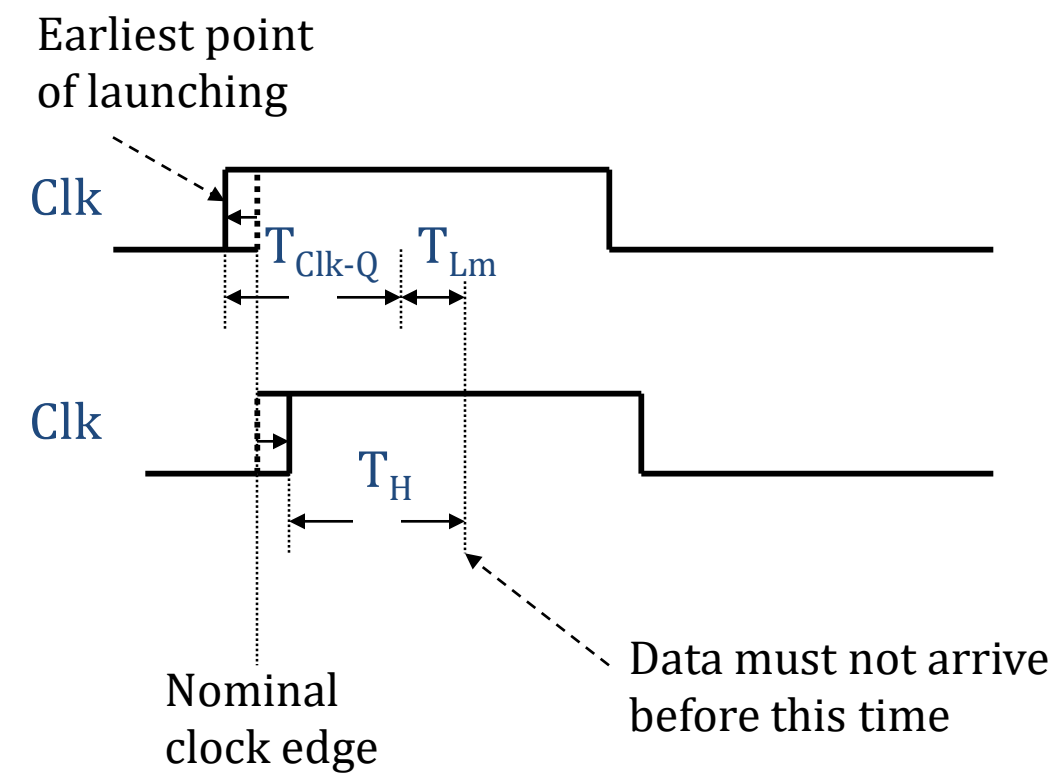




SHORTEST PATH

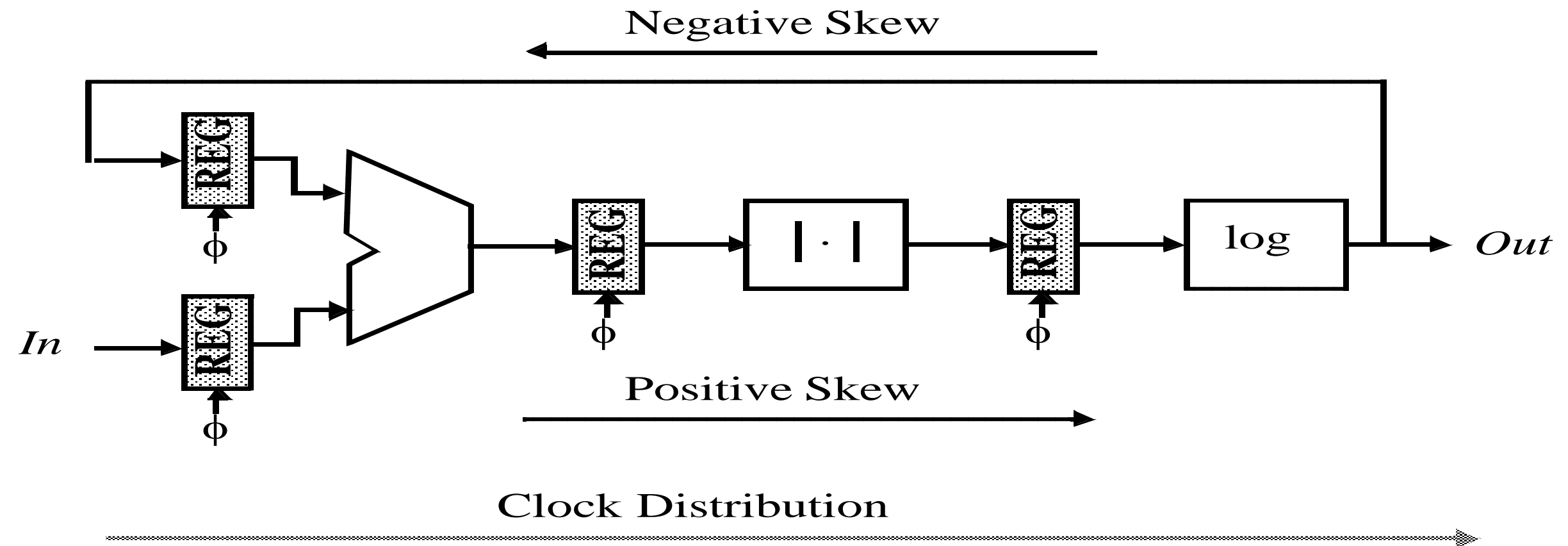


Worst case is when receiving edge arrives late
Race between data and clock





HOW TO COUNTER CLOCK SKEW?



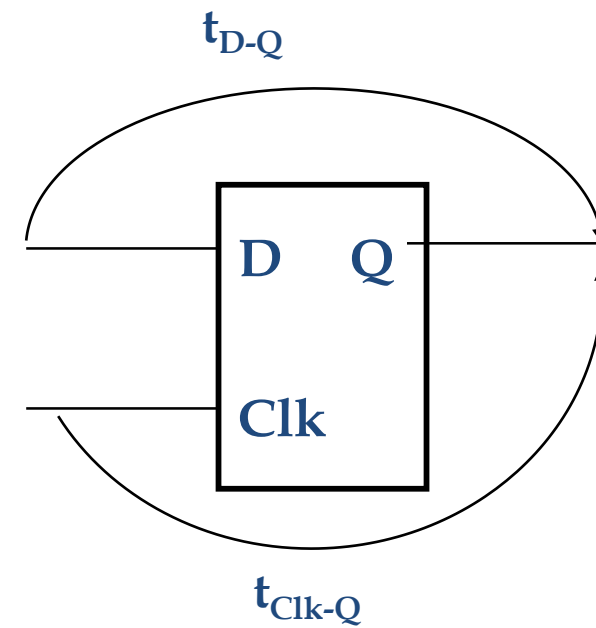
Data and Clock Routing



LATCH TIMING



- When data arrives
- to closed latch
- Data has to be 're-launched'



•Latch is a 'soft' barrier

- When data arrives to transparent latch



ASSESSMENT



1. Compare latch & Register parameters
2. Define Clock Skew & Jitter
3. Differentiate positive skew & negative skew
4. How to counter clock skew?



SUMMARY & THANK YOU