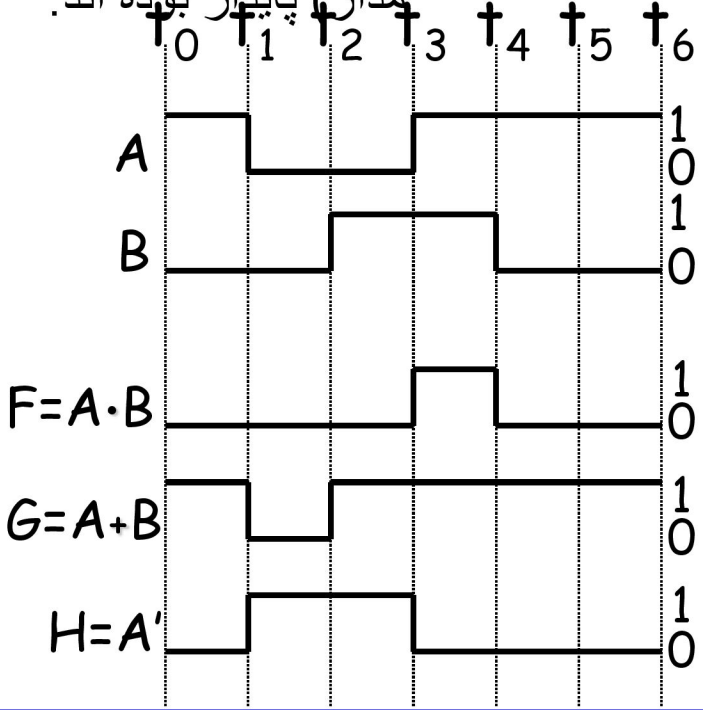
Hazard

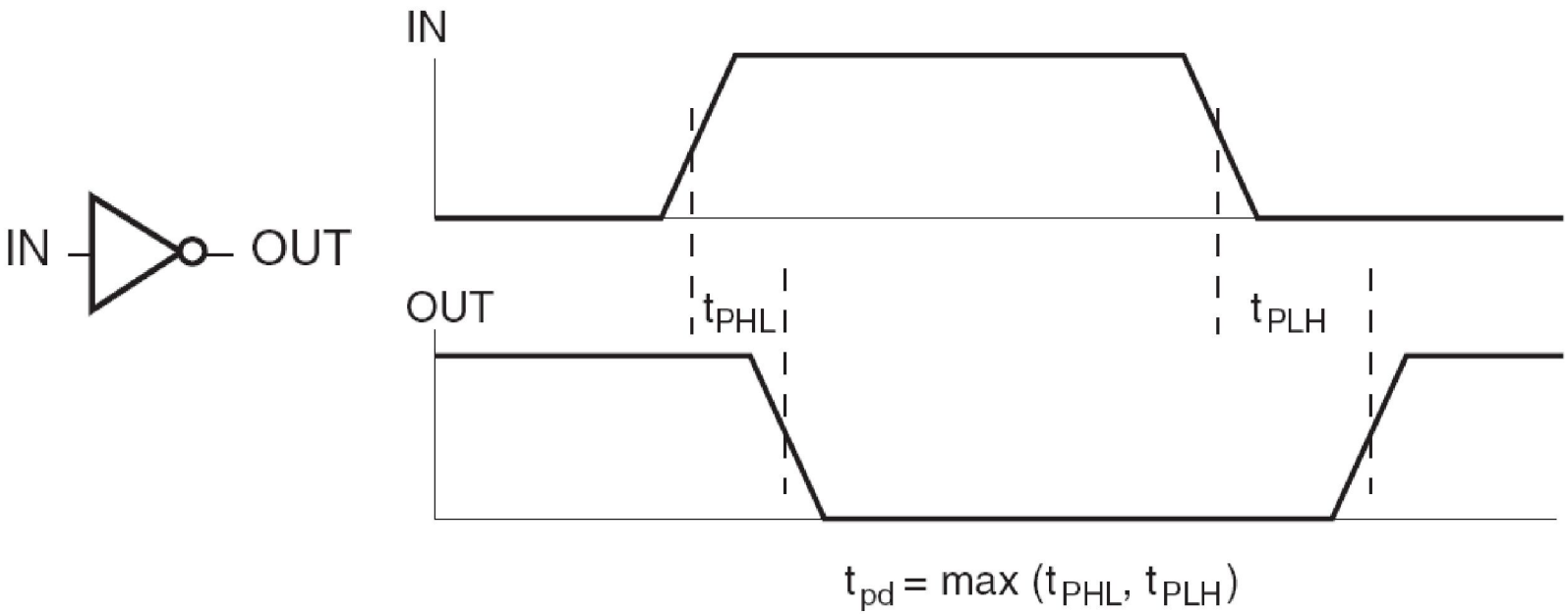
شكل موج ها

- تا به حال تاخير گيت ها در نظر گرفته نمي شدند:
  - تاخير صفر: غير واقعي
  - يا علاقه به دانستن رفتار حالت پايدار
    - فرض: ورودي ها براي مدت طولاني (نسبت به تاخيرالمان هاي مدار) پايدار بوده اند.



تاخیر

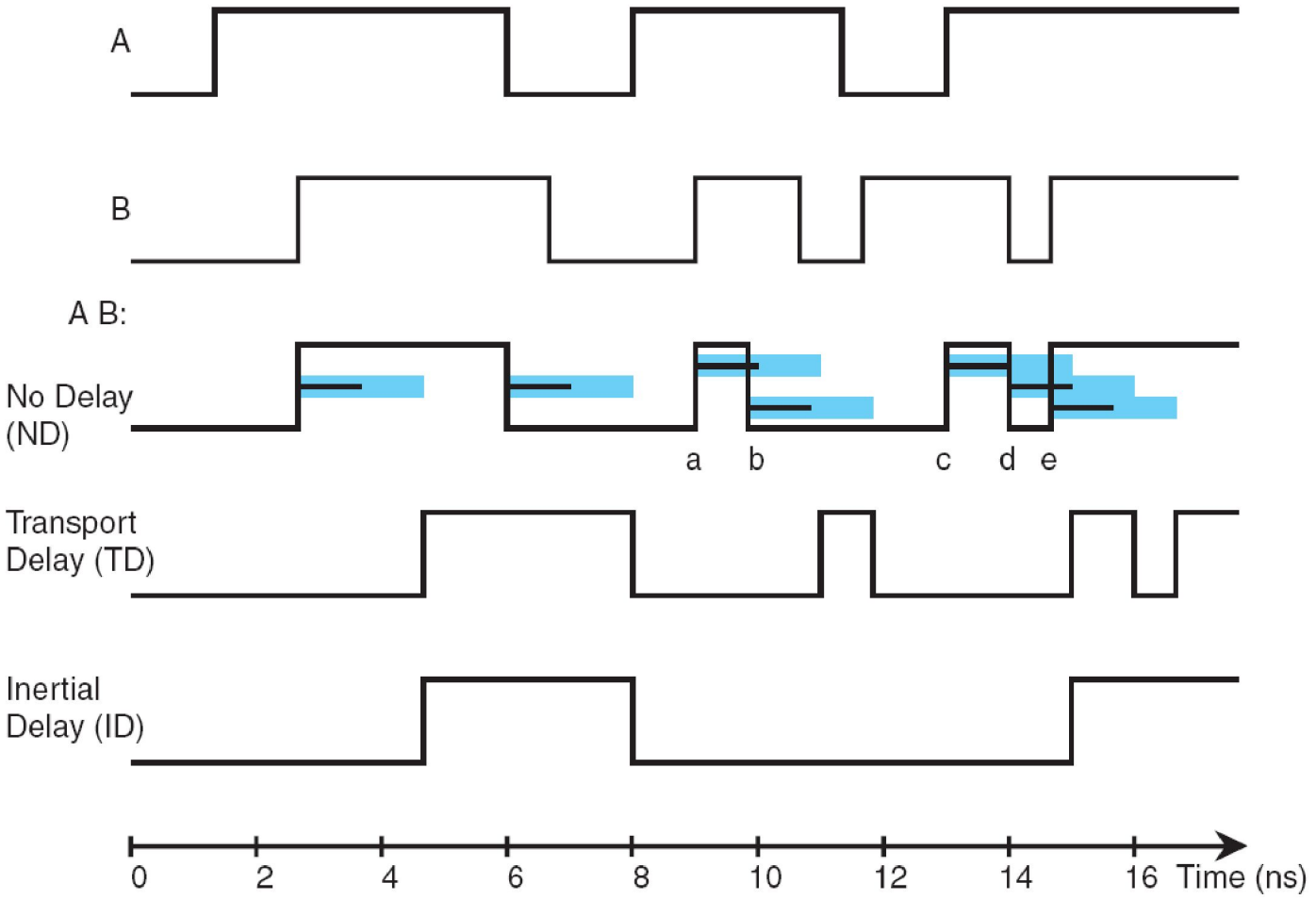
- تاخیر در مدارها



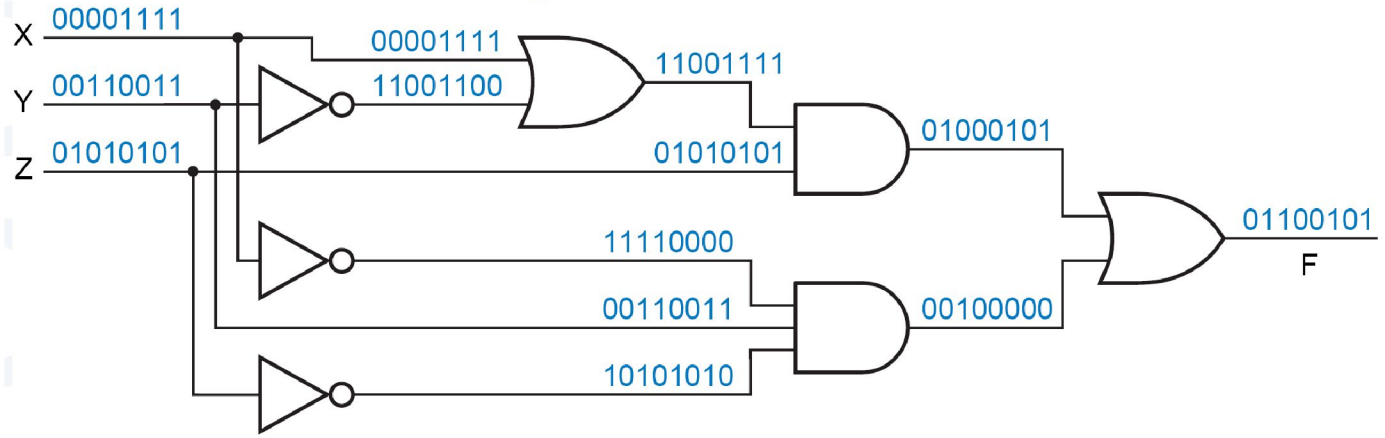
Propagation Delay for an Inverter

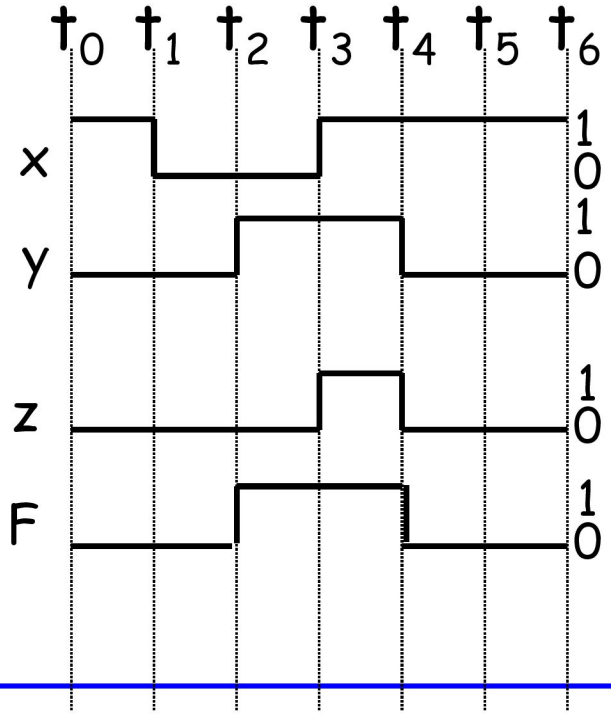
تاخیرها

- Inertial Delay
- Transport Delay



شکل موج ها


X
Y
Z
00001111
00110011
01010101
00001111
11001100
11001111
01010101
01000101
11110000
00110011
10101010
00100000
01100101
F

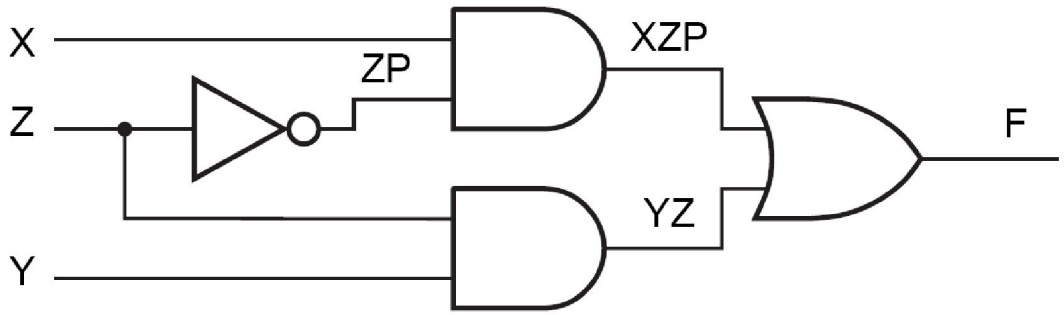

t0 t1 t2 t3 t4 t5 t6
x
y
z
F
1
0

Hazard

- تاخیرها ممکن است باعث پالس‌هاي ناخواسته شوند Glitch –

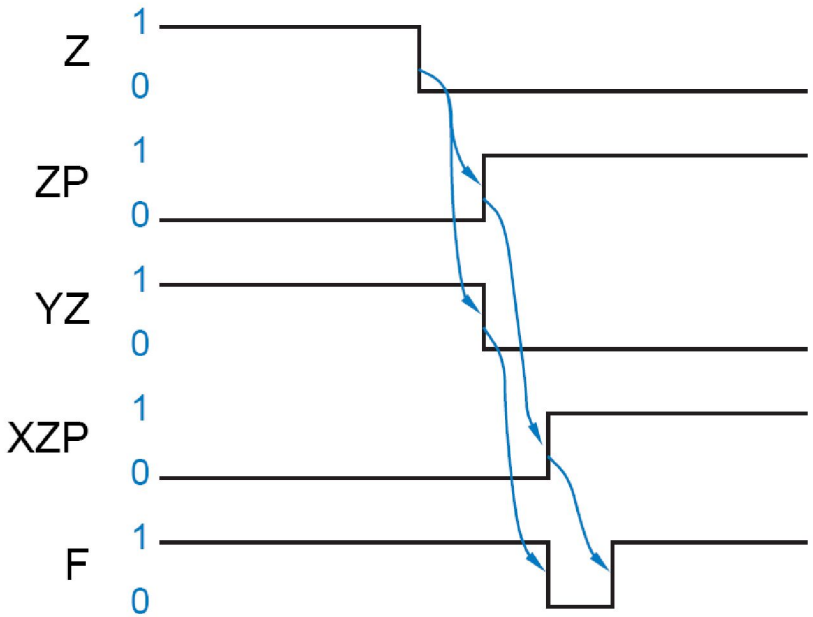
- **هازارد:**
  - مداري که احتمال ایجاد glitch در آن هست، هازارد دارد.
- **دو نوع:**
  - استاتیک
  - دینامیک

مثال



Initially:

X=Y=Z=1



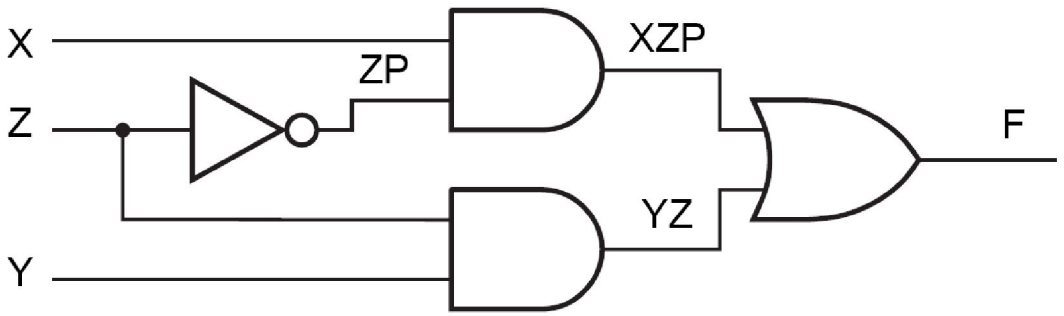
Static Hazard

- **Informal Definition:**
  - A static-1 hazard is the possibility of a 0 glitch when we expect the output to remain at a nice steady 1 based on a static analysis
- **Formal Definition:**
  - A static-1 hazard is a pair of input combinations that:

    (a) differ in only one input variable and

    (b) both give a 1 output such that it is possible for a momentary 0 output to occur during a transition in the differing input variable.

مثال



- Even though “static” analysis predicts that the output is 1 for both input combinations

  X,Y,Z = 111 and X,Y,Z = 110,

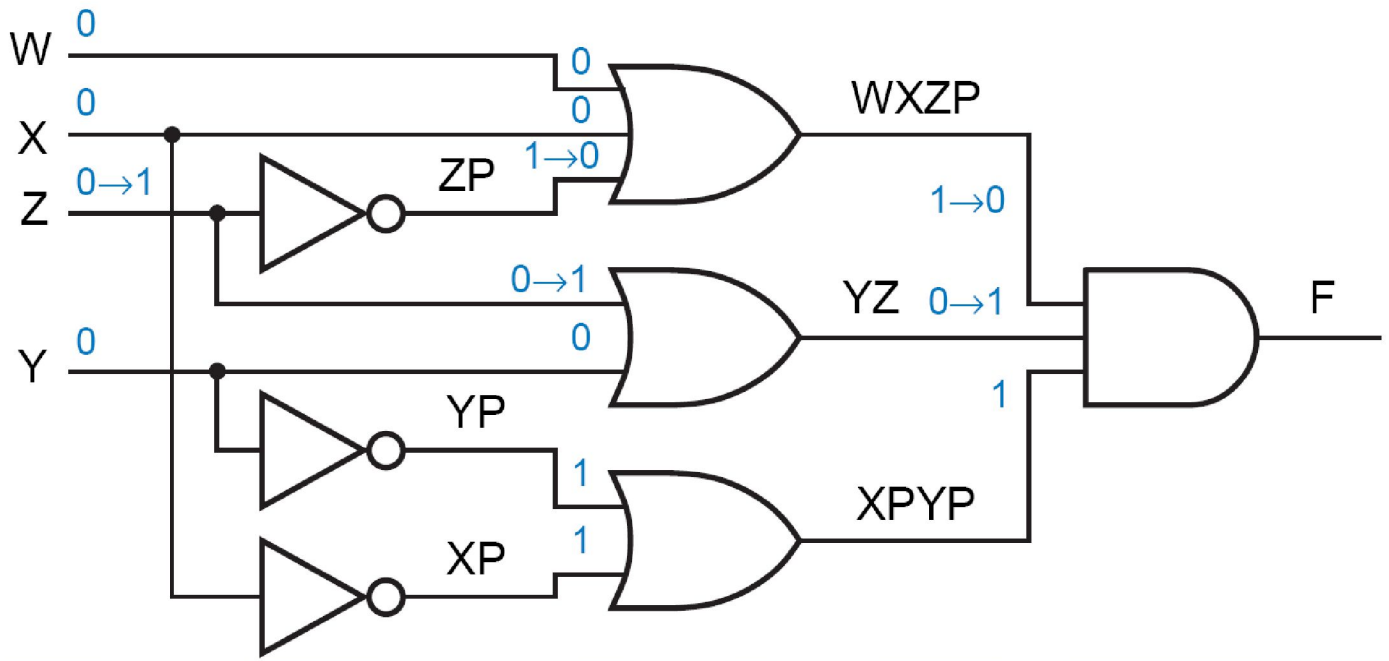
F goes to 0 for one time unit.

Static-0 Hazard

- A static-0 hazard is just the **dual** of a static-1 hazard
- A properly designed **two-level sum-of-products** (AND-OR) circuit can have no static-0 hazards
- An **OR-AND circuit** that is the dual of the example circuit could potentially have a static-0 hazard

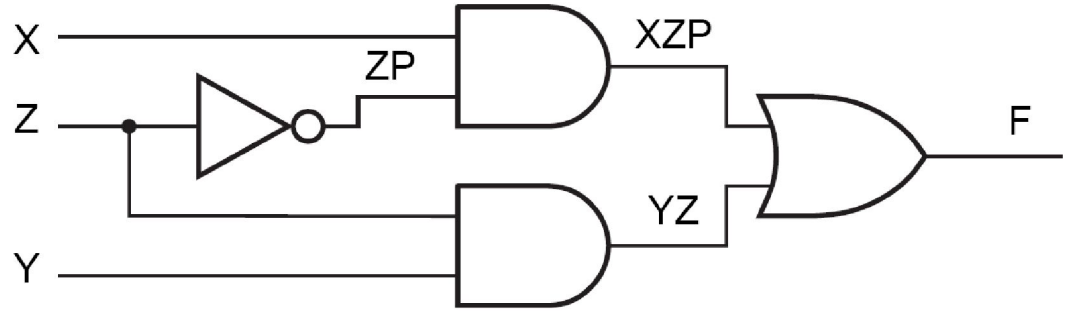
مثال

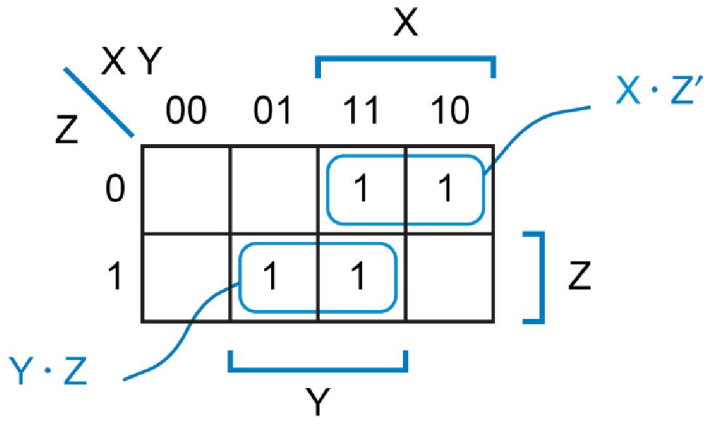
- تحلیل کنید:



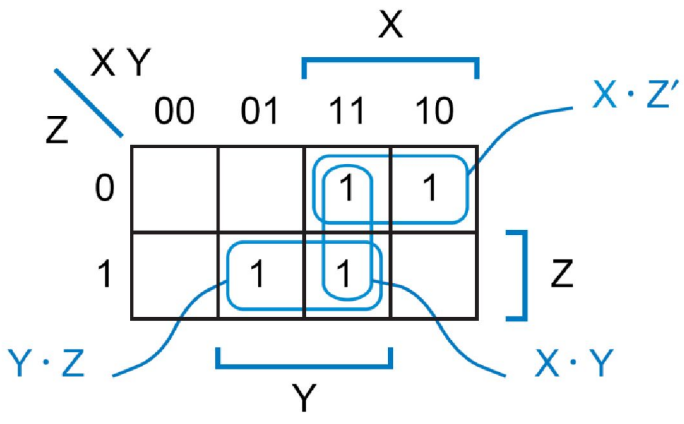
تشخیص هازارد

- A **Karnaugh map** can be used to detect static hazards in a two-level SoP or PoS circuit:



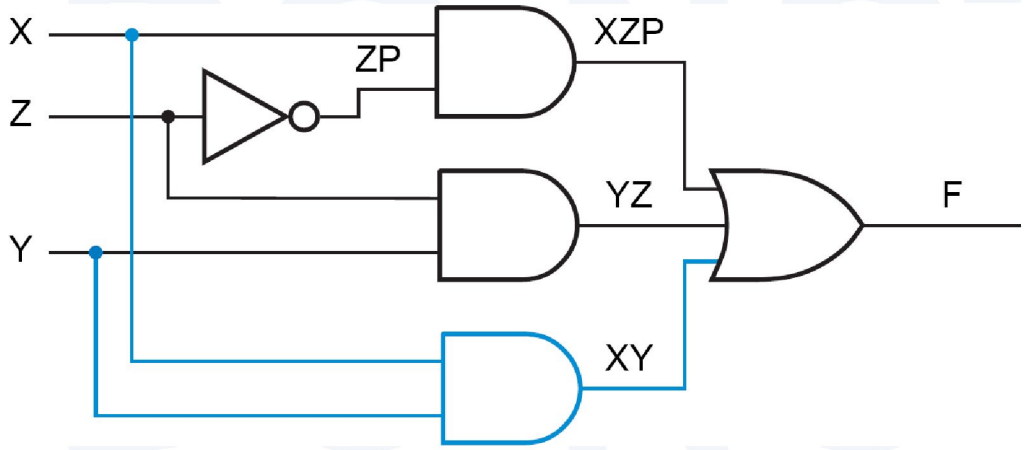


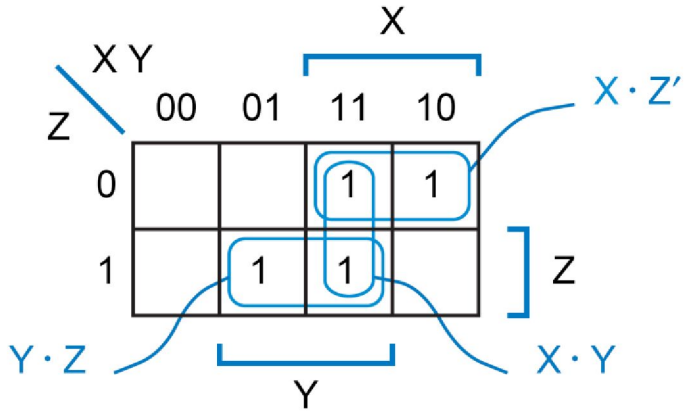
$F = X \cdot Z' + Y \cdot Z$



$F = X \cdot Z' + Y \cdot Z + X \cdot Y$

رفع هازارد

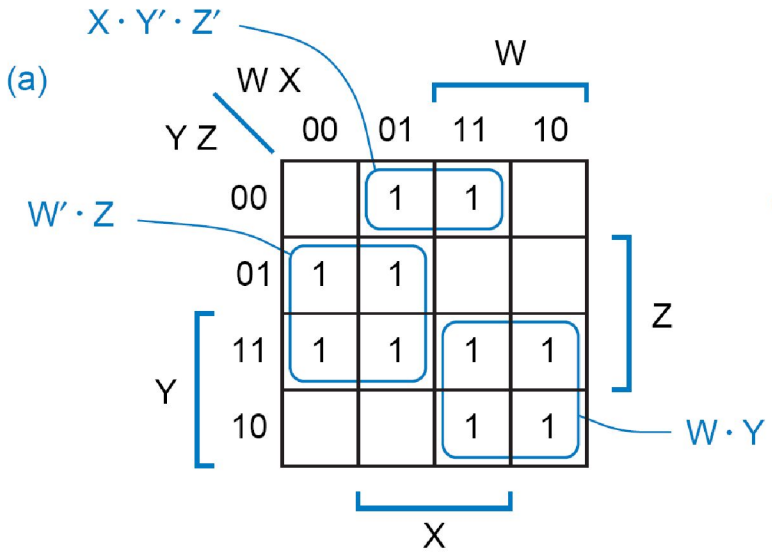




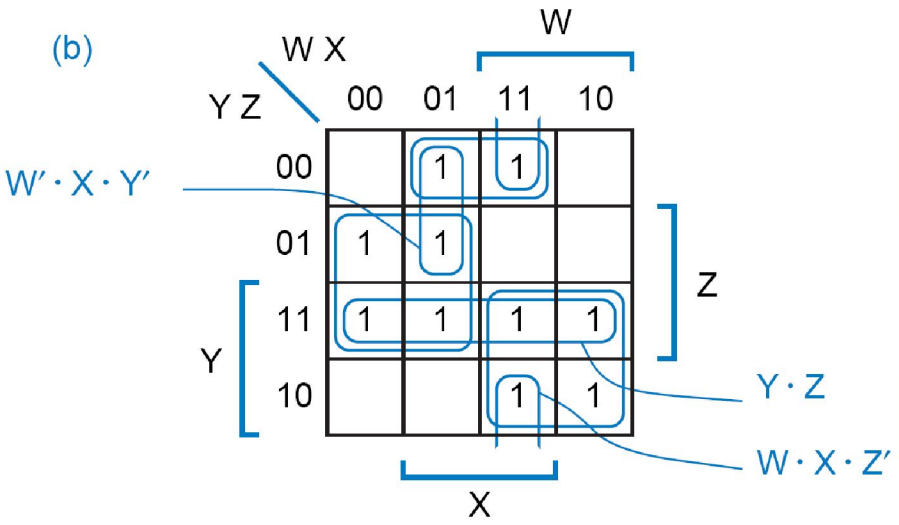
$$F = X \cdot Z' + Y \cdot Z + X \cdot Y$$

- Note the tradeoff between determinism and cost (number of gates)!

مثال



$$F = X \cdot Y' \cdot Z' + W' \cdot Z + W \cdot Y$$

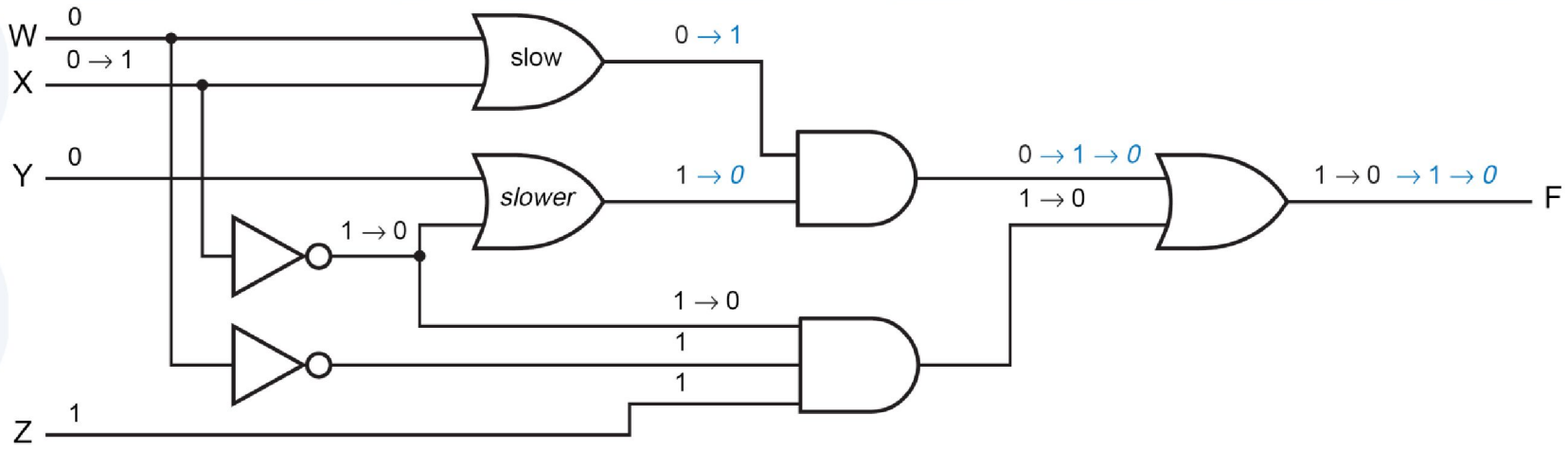


$$F = X \cdot Y' \cdot Z' + W' \cdot Z + W \cdot Y + W \cdot X \cdot Y' + Y \cdot Z' + W \cdot X \cdot Z'$$

Dynamic Hazard

- **Dynamic hazard:**
  - The possibility of an output changing **more than once** as the result of a single input transition.
    - Multiple output transitions can occur if there are **multiple paths with different delays** from the changing input to the changing output.

مثال



- سه مسیر از X به F با سه تاخیر مختلف
- F=1 ← W,X,Y,Z = 0,0,0,1
- فرض: X یک شود.
- فرض: دو OR میانی کند و بقیه گیت‌ها عادی هستند.
  - اول تغییرات مشکي ← F=0
  - بعد آبي غير ايتاليک
  - بعد *آبي ايتاليک*

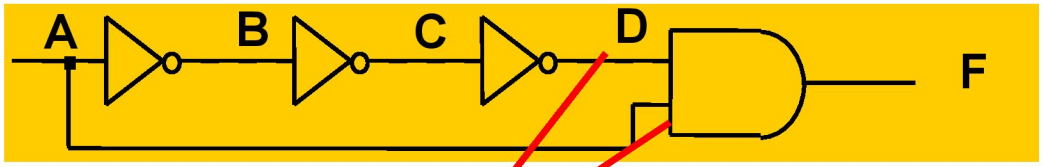
Hazard-Free Design

- Techniques for finding hazards in arbitrary circuits, are rather difficult to use.
  - → when you require a hazard-free design, it's best to use a circuit structure that is easy to analyze.
- In particular, two-level AND-OR circuit has no static-0 or dynamic hazards.
- Static-1 hazards may exist in such a circuit but they can be found and eliminated using K-map.

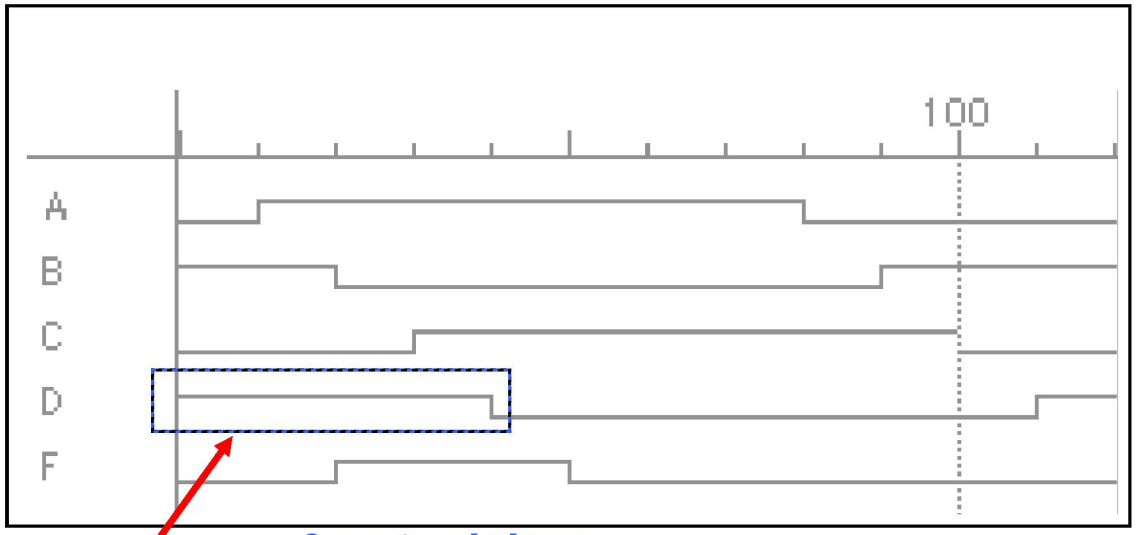
نکته

- **Most Hazards are not hazardous:**
  - A well-designed, *synchronous* digital system is structured so that hazard analysis is not needed for most of its circuits.
  - In a synchronous system, all of the inputs to a combinational circuit are changed at a particular time, and the outputs are not “looked at” until they have had time to settle to a steady-state value.
  - Hazard analysis and elimination are typically needed only in the design of asynchronous sequential circuits.
  - Asynchronous circuits are not the mainstream but if you want to design them, an understanding of hazards will be absolutely essential for a reliable result.

Pulse-Shaping Circuit



A' •A = 0



3 gate delays

D remains high for three gate delays after A changes from low to high

F is not always 0!